Fachhochschule Dortmund
University of Applied Sciences and Arts

International Research Conference 2014

CONFERENCE PROGRAMME – 27th June 14

- International Forum for Researchers, Master and PhD. students
- Colleagues from different Faculties and Partner Universities
- Presentation and Discussion of Trends and Research Results
- Several modules contributing to Project Management

International Research Conference in Dortmund 2014

In 2010 we started the International Research Conference at the Dortmund University of Applied Sciences and Arts and continued this conference since 2010 every year - and now for the fifth time.

The complete series of conferences is documented and results are available as a wikispace http://internationalresearchdortmund.wikispaces.com/ .

The conferences were shaped mainly by contributions of students and staff of the community of the European Master in Project Management – EuroMPM – from Dortmund, Bilbao, Riga, Kaunas, Szeged and further countries. It is a place where master students and scientists find a forum for the presentation and discussion of the whole spectrum of activities within the EuroMPM. It is intended to set new directions for the EuroMPM and to find new areas for further research and teaching.

This year, the conference again covered a wide range of topics. We had Anatoly Sachenko from Ternopil as a visiting guest. This long time partner will join the European Master in Project Management with a Masters programme in Ukraine. Several graduates of the EuroMPM were presenting results from their practical project management experience in the industry. EuroMPM students and Master students from IT and engineering were presenting their recent work. Our friends and partners from Bilbao, Riga, Kaunas and Szeged gave an insight into their ongoing work and research. The scope of the conference was again completed by the lecturers and researchers from the Dortmund EuroMPM.

This conference has its own spirit and power since the beginning in 2010.

In 2014 the conference has 5 sessions:

Session 1 - Project Management, Session Chair: André Dechange

1. Aspects of Project Controlling with Regards to Uncertainties (Wolfgang Tysiak. University of Applied Sciences and Arts Dortmund)

2. Development of an Integral Model for Project Management (Egidijus Bartusis, André Dechange. University of Applied Sciences and Arts Dortmund)

3. Understanding Collaboration Needs within the Communities of Practice that form tyntec (Naiara Pupo. tyntec GmbH, Dortmund)

4. ISO9001:2015 and PMI PMBOK v5: Analysis of revision changes and future requirements for quality management in projects (Sascha Tobias Richter, Alex Sereseanu)

Session 2 - Projects and Business, Session Chair: Wolfgang Tysiak

5. Political Economics and Project Management as its Gear Box to Business Administration (Werner Wetekamp. University of Applied Sciences and Arts Dortmund)

6. Financial Literacy and Retirement Planning (Katrin Löhr. University of Applied Sciences and Arts Dortmund)

7. Success Factors of Innovation Management in Small and Mid-sized Enterprises (Büchler, J.P., Faix, A., Stuber, S.J.. University of Applied Sciences and Arts Dortmund)

8. Unveiling Innovation beyond Ecodesign: Basque Experience as a Case Study (Paulina B. Jones Mercedes, José Ramón Otegi Olaso. University of the Basque Country, Bilbao, Spain)

Session 3 - Application Cases, Session Chair: José Ramon Otegi

9. Efficiency Problems in Public Sector Projects Planning and implementation Stage (Emils Pulmanis. State Regional Development Agency, Latvia)

10. Project management process in public projects in Latvia (Silvija Bruna. University of Latvia, Riga, Latvia)

11. Student Evaluations of Courses in Business Studies. A Validation of Eduqual Method (Éva Málovics. University of Szeged, Hungary)

Session 4 - On Technology - Tools and Processes, Session Chair: Christian Reimann

12. Designing Smart Systems: Developing the M2M Smart Systems Readiness Canvas (Ala Nusseibeh, Carsten Wolff. University of Applied Sciences and Arts Dortmund)

13. Design Processes for Embedded Systems (Annika Eder, Sebastian Triesch. Smart Mechatronics GmbH, Dortmund)

14. Conceptual framework for localisation of social networking sites (Elena Vitkauskaite. Kaunas Technical University (KTU), Lithuania)

15. Partitioning and Mapping for Embedded Mutlicore System Utilization in Context of the Model Based Open Source Development Environment Platform AMALTHEA (Daniel Fruhner, Robert Höttger, Sebastian Köpfer, Lukas Krawczyk. University of Applied Sciences and Arts Dortmund)

Session 5 - On Technology - IT Systems, Session Chair: Elena Vitkauskaite

16. A remote management concept for distributed energy information and facility management systems (A. Killert. Institute of Communication Technology - University of Applied Sciences and Arts Dortmund)

17. A web-based data analysis system with a flexible data link and dynamic GUI parameterization (E. Grundmann. Institute of Communication Technology - University of Applied Sciences and Arts Dortmund)

18. Predictive Analysis on SAP HANA (David Müller, Christoph M. Friedrich, Christoph Engels. University of Applied Sciences and Arts Dortmund)

We thank all authors for the contributions to the International Research Conference in Dortmund 2014. The contributions are important – as well as the discussions – and the evolution of the community – and the growing power to meet the requirements of the future.

Greetings from the flow of strong projects

Peter Reusch and Carsten Wolff

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ASPECTS OF PROJECT CONTROLLING WITH REGARD TO UNCERTAINTIES

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Keywords: project management, risk management, monitoring and controlling of risks

Abstract: If there are uncertainties in a project, let it be in durations, in quality or in costs, you have to work with probability distributions. PERT, for example, uses beta distributions to calculate durations that are described by only three values (optimistic duration, most probable duration, and pessimistic durations). PERT then determines the critical path by taking into account the expected durations and builds the convolution of the densities along the critical path.
The main problem in this method is the fact that if you deal with probabilities, you do not have a unique critical path anymore. As a result the whole controlling process becomes more complex. Especially any approach that is based on the critical path is very problematic because the critical path determines the start and finish dates of the individual activities by calculating the project back and forth. As a consequence, the occurrence of an extreme duration at the end of the project can be crucial also for the beginning of the critical path.
In this contribution we will look at a fictitious project, execute a Monte Carlo simulation in advance, then assume realizations and analyze the consequences to the distributions of the remaining tasks.

1 Introduction

As a project is "a temporary endeavour undertaken to create a unique product, service, or result" [1], every project contains risk and managing these risks often becomes a critical concern. Therefore in every project there is the need to implement some kind of risk management (cf. [1], [2], [3]), which normally contains the following phases:

(1) risk management planning,
(2) risk identification,
(3) qualitative risk analysis,
(4) quantitative risk analysis,
(5) risk response planning, and
(6) risk monitoring and control.

This has to be seen more or less as a chain or better as a circle that you permanently have to work through. But as a chain, this process is as weak as its weakest link. So if you are not able to identify the really crucial risks, there is nothing to analyze. If you are not able to evaluate risks and therefore cannot plan how to respond in an adequate way, you cannot handle the risks.
The risk management plan defines the roles and responsibilities, the risk budget, the methodologies etc. in the beginning. Therefore you can see this as setting the infrastructure of the risk management process. The next steps are the risk identification process and the

qualitative and quantitative risk analysis. Especially in the steps (3) and (4) some analytical/statistical methods have to be used because you have to work with uncertainties and therefore with densities and distributions.
Risks in projects can occur in different dimensions, such as time, costs, quality etc. A risky event that may happen is normally characterized by two aspects: The probability of occurrence and the impact that is a consequence out of this event. Both aspects possess probability distributions that have to be estimated. But already at this stage we can deduce that a planning process can never forecast the exact realization of such an event, if only distributions are estimated.
Let us now assume that the steps (1) to (3) have already been done, look a little more into the details of step (4), skip step (5), and look predominantly to the consequences for the risk monitoring and controlling phase.

2 A Fictitious Project

In this contribution we will only consider uncertainties related to time. A commonly used approach to deal with this is PERT (cf. [3], [4]), but as previously shown (cf. [5], [6], [7]) there are some known disadvantages of this method. We will mention them here, but also show how to overcome them (cf. [8], [9]). Let us start with the project plan given in fig. 1. Because the original PERT assumes beta distributions that easily allow the calculation of the expected durations (ED = (OD + 4 MD + PD)/6) and the standard deviations (STD = (PD – OD)/6) of the individual activities, these values are also provided here.

Activity	Predecessors	OD	MD	PD	ED	STD
A	-	2	3	4	3,000	0,333
B	-	3	6	9	6,000	1,000
C	-	2	5	10	5,333	1,333
D	-	4	6	9	6,167	0,833
E	A, B, C	3	7	10	6,833	1,167
F	C, D	2	7	9	6,500	1,167
G	E	2	3	4	3,000	0,333
H	E, F	3	6	8	5,833	0,833
I	F	3	6	9	6,000	1,000
J	F	2	7	10	6,667	1,333
K	G, H, I	2	6	8	5,667	1,000
L	I, J	3	5	8	5,167	0,833

Fig. 1. A fictitious project plan

We do not want to discuss the PERT approach here in detail (e.g. the assumption of beta distributions), because this is well documented in the common textbooks. The basis of the PERT approach is the critical path, calculated with the expected values, and the convolution of the distributions along this critical path that leads (due to the central limit theorem) to a normal distribution with the given expected values and standard deviations. In order to give an impression of the structure of the project and because in the following parts we will several times look at the “criticality” of the individual activities, the net and the critical path (bold arrows) that is used for the PERT approach is shown here (cf. fig. 2).

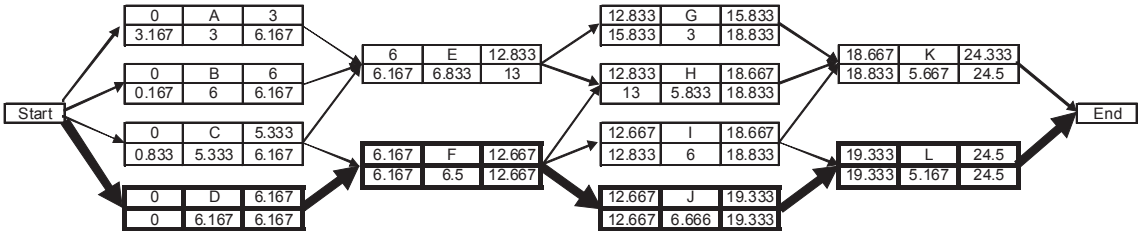

Fig. 2. Net and critical path (used in PERT)

Afterwards a Monte Carlo simulation was performed: 10,000 cases were generated following exactly the same beta distributions for the durations of the individual activities that were used in PERT. Fig. 3 shows the graph of the normal distribution of the total duration of the project that was the result of PERT and additionally the distribution of the Monte Carlo Simulation.

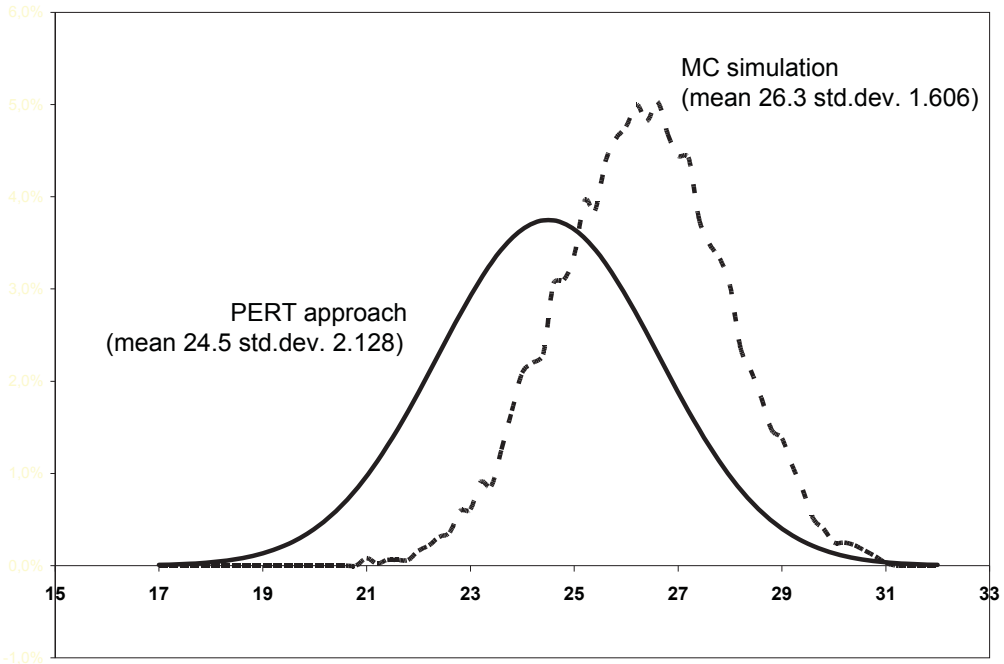

Fig. 3. Distribution of the total duration of the project

As it is clearly seen, the PERT approach underestimates the real risk. The reason for this is the fact that if you deal with distributions, there no longer exists a unique critical path and consequently the whole PERT approach fails. Additionally PERT does not take into account that within the calculation of the critical path you frequently have to use the maximum function. This is the main reason for the fact that the real mean is higher and the standard deviation is smaller (cf. [6]). Within the project you will find activities that are totally uncritical (0%) or critical (100%). But the most common case will be that there is a probability between zero and one that an activity becomes critical (cf. fig. 4). For this reason we use the term “critical field” instead of “critical path”. By comparing fig. 2 and fig. 4 we see that the critical activities in the PERT approach not necessarily coincide with the activities with the highest probabilities to become critical in the Monte Carlo approach. And not only the property of being “critical” have now to be described by distributions, also for the buffers we only get distributions: If you start with distributions, you will have distributions within all calculations (cf. [7]).

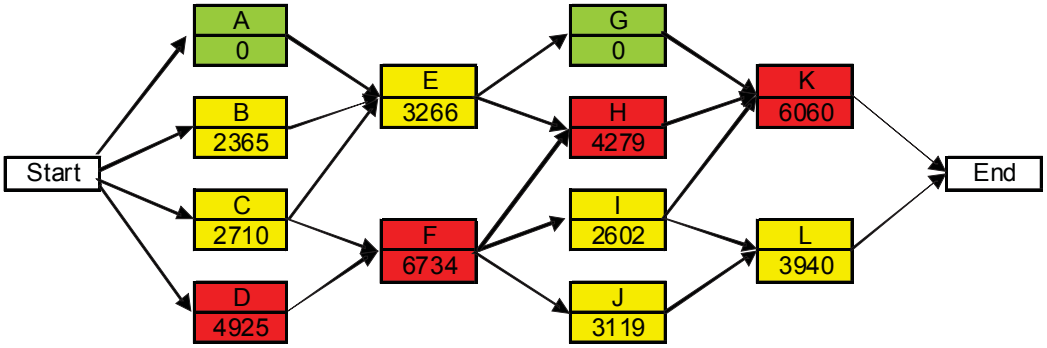

Fig. 4. Number of times that an activity belongs to the critical path (N = 10,000)

In the beginning, when the activities A to D can be started in parallel, A can never be critical, B and C with probabilities between 20% and 30%, whereas activity D (with a probability of 50%) is the activity that most likely becomes critical. If you compare these probabilities with the parameters OD, MD, and PD in fig. 1, you recognize that the probability of being critical not only depends on PD, but on the whole shape of the distribution. Here is also a first hint for further research: What happens if we assume other distributions?

3 Consequences for the Control Process

In practice the critical path is the common guideline for the controlling process. Therefore you need a change in paradigm if you understand that in the case of uncertainties there is no unique critical path. You can easily show that different realizations within the ongoing process lead to different changes in the critical path (cg. [10]). Moreover because of the back and forth calculation of the critical path, it is also possible that a single uncertain event at the end of the project may change the whole critical path, also in the very beginning of the project. (Here some analogies can be found to the Wagner-Whitin approach in dynamic lot sizing.)
To show this in our example, we assume that we observed exactly the realizations that led to the critical path that is shown in fig. 2 apart from the fact that in activity K we realized a duration of 8. This will lead to a critical path that is shown in fig. 5. As it is clearly visible, this single change leads to a different critical path: Some activities that formerly were critical are no longer critical and the other way around. Additionally the new critical path contains parallel critical activities.

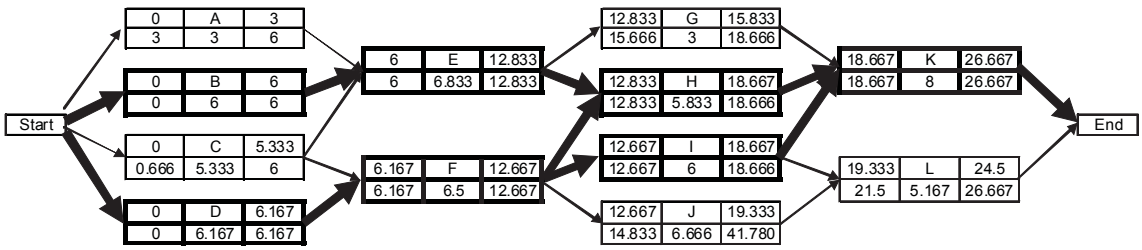

Fig. 5. Net and critical path with duration of 8 in activity K

4 Conclusions and Remarks

If one understands the monitoring and controlling process within a project mainly as the comparison between the nominal/target/planned values and the actual/performance values – as it is often seen – this leads to a totally wrong approach as soon as uncertainties are assumed: There are no fixed target values. Introducing uncertainties, probabilities, distributions etc. means a change of paradigm: This cannot be handled by further acting as having mainly a deterministic approach and just adding some "risk features", as it is done for instance in PERT. A project is usually characterized by items as "uniqueness" or "complexity" and hence you have to accept uncertainties in your project parameters. But this leads necessarily to totally different techniques to apply. Let us just mention here project management in a specific application like software engineering (cf. [11]) or R&D (cf. [12], [13]), where the use of uncertainties is inevitable.
If you accept uncertainties in your project this has in most cases consequences for the whole monitoring and controlling process. This is quite obvious because planning and controlling are always very strongly connected. The main problem is that you cannot have planned values that have to be controlled; moreover you have to check the sequels of the actual values permanently. This task therefore should be supported by a model (e.g. Monte Carlo simulation model) that could easily show the influences of the actual data and offers deeper insights into the dynamics within a project plan.

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Development of an Integral Model for Project Management

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Keywords: Integral Theory, Integral Model, Holonistic approach, Holacracy, Project Management, Crystal Ball

Abstract

The goal of this paper is to develop an Integral Model for Project Management. To achieve this goal, existing integral models, approaches and tools for project management are introduced. By combining and adapting different models and perspectives a holistic approach for project management is tailored. It is believed that new Integral Model will help project managers to look at a project management from a holistic point-of-view, not losing focus on the project goal. This approach should strengthen the relationship between team members, improve work environment, increase efficiency and project success rate by helping to prevent or avoid pitfalls.

1. Introduction

Projects have already become a critical and integral part of corporate success, yet research reveals the shocking truth – most of the projects do not succeed. (PriceWaterhouseCoopers, 2004; The Standish Group, 2013). Organizations worldwide have implemented and developed number of rules, tools and methodologies to help deal with this problem. (Business Improvement Architects, 2005) However, according to the Standish Group research (2013) still without expected results.

This research proposes that current project methodologies and tools are not enough to achieve project success (Levine, 2002), and a broader, balanced and integral approach to project management should be developed. (Munns & Bjeirmi, 1996). There is a need for a holistic model that could combine all interconnecting pieces of project management and would ensure 360^{o} vision. (Cacioppe & Albrecht, 2000; Wilber, 2006; Edwards, 2004). To be really useful, the model has to be practical, effective, easy to use, and it should be integratable with existing methodologies, systems and structures. (Esbjörn-Hargens, 2010; Robertson, 2007).

To fulfill these requirement this research tailors an Integral Model (Crystal Ball) based on Ken Wilber's Integral Theory (2006), Brad McManus's & Ron Cacioppe's Integral Approach for Project Management (2011) and Brian J. Robertson's Holacracy practice (2006). In addition, this paper points out benefits, drawbacks and usability of the Integral Model.

2. Integral Theory by Ken Wilber

In the past, people usually spent their entire life in an enclosed environment: in one culture, often in one country, sometimes in one house, where they lived, worked, and died. (Wilber, 2006). Cross-cultural exchange was an unheard term until 1930s (Murdock, 1940) and the culture and knowledge was passed only within the family down

through generations. Today the view is totally different, people are not only geographically mobile, but they can study, and actually most of them have studied, almost every known culture on the planet. As cultures now are exposed to each other and knowledge became global, managers have a unique opportunity to tap into collective knowledge of human mankind. Study of past major human civilizations open the doors to virtually limitless sources of experience, wisdom, reflection and culture (Wilber, 2006).

Ken Wilber, the father of Integral theory, questioned (2006) what would happen if everything, that all mentioned cultures have to tell about human potential, spiritual growth, psychological growth and social growth, would be taken and put on one table and then analyzed. In 1998 Wilber founded the Integral Institute, which had a main purpose of finding an answer to latter question. By defining the critically essential keys to human growth, extensively studying of cross-culture traditions, he created a composite map, a comprehensive map, an all-inclusive or, in other words, **Integral Model** that included the best elements from all of the mentioned cultures.

Even according to the creator, Ken Wilber, (2006) introduction to Integral Model can at first look complicated, complex and daunting. In a sense, it is. However, if looked from other perspective the model is surprisingly simple and elegant. Model consists of five simple factors that are the essential elements or keys that help to unlock and facilitate human evolution. These five elements are called quadrants, levels, lines, states and types. Often this model is abbreviated AQAL, which stands for (All-Quadrants, All Levels), but equally connotes All-Lines, All-States and All-Types. Sometimes it is also alternatively called the Integral Operating System (IOS). (Wilber, 2006).

When talking about Integral Model, often term “holon” is mentioned. This term was “originally coined by Arthur Koestler, basing it on the Greek word “holos” for “whole” and the suffix “-on” that denotes “part””. (Michael Schillo, 2002, p. 55). Wilber states (1996) that everything in the universe is composed from part-wholes or holons. Entities that are a whole, simultaneously are a part of some other whole. An individual is part of a whole team and a team is part of a whole organisation and so on. Each of these entities are neither just a whole nor just a part, but a whole/part, a “holon". (Wilber, 1996; Cacioppe & Albrecht, 2000). Taking this into consideration, holon can be seen as a recursive entity.

Figure 1 shows a visual representation of AQAL model. Model is divided into four quadrants: “I’, ‘We”, “It’ and “Its”. Quadrants depict four perspectives (subjective, intersubjective, objective, and interobjective) which forms a lens that helps to understand any issue or aspect of reality. Esbjörn-Hargens, a founding director of Integral Research Center, seconds (2010) Wilber proposal that everything can be analyzed from two fundamental point-of-views:

1. Inside – Outside perspective
2. Singular – Plural perspective

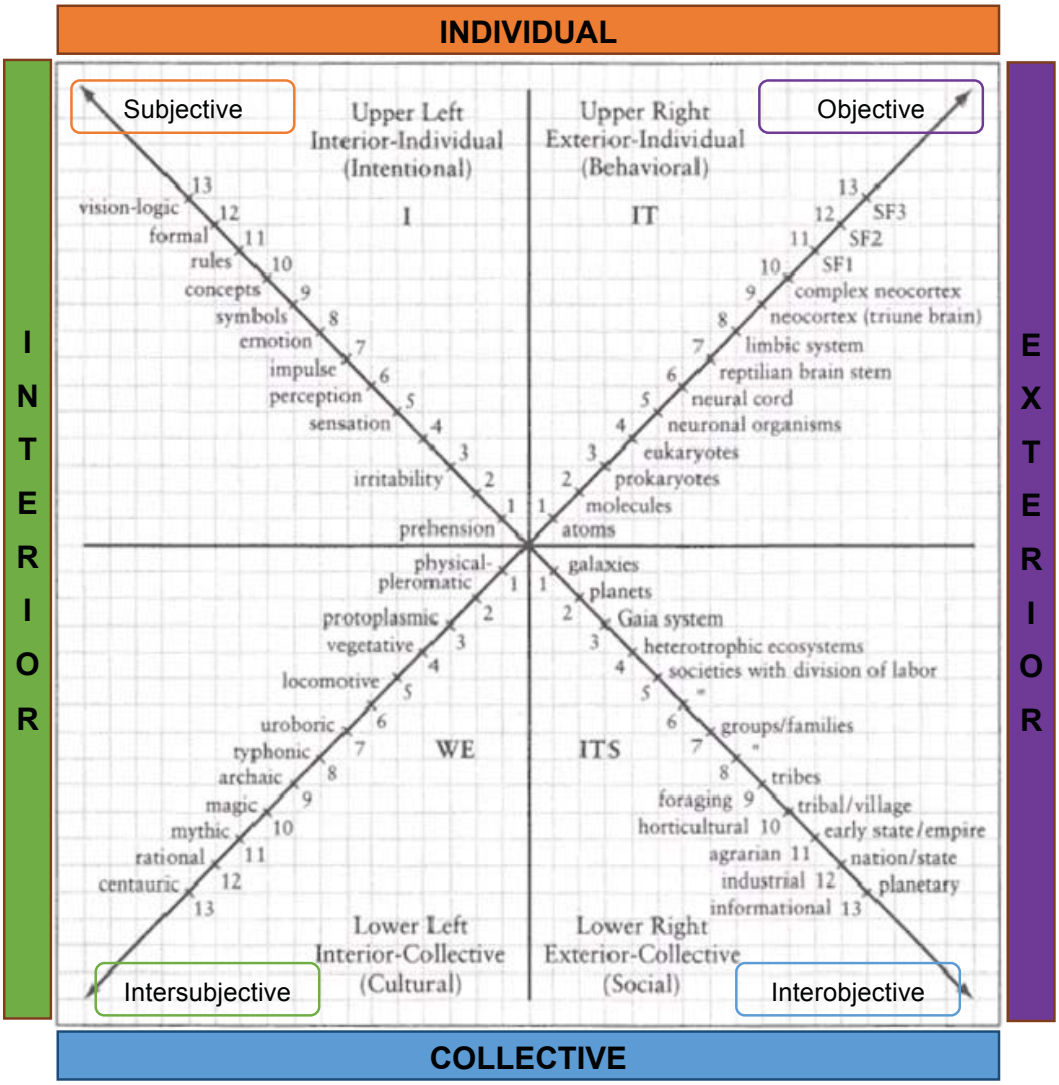

Figure 1. AQAL model developed by Ken Wilber

The four quadrants of AQAL model can be observed as actual aspects of the world that are always present in each moment, in other words, a dimensions of reality. According to Wilber (1996), the quadrants should be valid for all holons and to collapse them all together or dismiss one of these perspectives is often a serious mistake.

The perspectives are holistic and cover everything. However, it can be abruptly categorized by effect on people and their behavior from respective sociopsychological context:

- **Interior individual accounts (upper-left quadrant)** include Freudian psychoanalysis, which interprets people's interior experiences and focuses on "I".
- **Interior plural accounts (lower-left)** include Gadamer's philosophical hermeneutics which seeks to interpret the collective consciousness of a society, or plurality of people and focuses on "We".

- **Exterior individual accounts (upper-right)** include B. F. Skinner's behaviorism, which limits itself to the observation of the behavior of organisms and treats the internal experience, decision making or volition of the subject as a black box, and which with the fourth perspective emphasizes the subject as a specimen to examine, or "It".
- **Exterior plural accounts (lower-right)** include Marxist economic theory which focuses upon the behavior of a society (i.e. a plurality of people) as functional entities seen from "Outside".

All four AQAL model accounts pursuit: psychoanalysis, behaviorism, philosophical hermeneutics and Marxism offer complementary, rather than contradictory, perspectives. It is possible for all of them to be correct and necessary for a complete account of human existence. (Storck, 2012).

3. Organization-orientated Integral Model

This paper assumes that project management takes place in an organization that by definition involve more than one person. To create *whole* Integral Model for Project Management, it is important to analyze how Integral Model fits into organization and which perspective is used.

The Integral Model is developed in a way to be applicable to any human area of interest: to ongoing world events, to organizational situations, to leadership challenges, or to analysis and development of business environment. (Howard, 2005). If a business is not a start-up, it has most likely established an interlocking set of goals, roles, processes, values, beliefs, communications practices, attitudes and assumptions. These elements fit together so tightly that if even a single element is effected, other will resonate. (Denning, 2011). An Integral perspective allows to understand these dynamics of change, relations between different business entities, diagnose complex interrelating business situations and develop corporative strategies. It can be used as a tool for business or project leaders in developing their systematic, integrative and holistic business approach. Furthermore Integral Model not only integrates other approaches, models, tools and techniques but also compliments them, by providing more holistic point-of-view to understanding separate pieces and to putting them together. (Howard, 2005).

AQAL matrix (Figure 1) fits business by being both individual holon, as organisation always exist to fulfil a common purpose that is shared by its members, and collective holon, as organization involve more than one person. Organizations also are usually categorized into public (external holon) and into private (internal holon). Government and publicly owned organisations fall into public category and all the other falls into private category, which can be also sub-divided into profit (corporations) and non-profit (NGOs). (Bunzi, 2011).

A simple example can illustrate how model can be used in an everyday organizational environment: let's assume that the goal is to understand the components of a successful meeting at work. Internal holon of individuals and groups would reflect psychological insights and cultural beliefs of the meeting participants, and external holon including the same perspectives (individual and collective) would reflect behavioral observations and organizational dynamics. This could help fully understand what is worthwhile in a constructive meeting (Esbjörn-Hargens, 2010).

4. Holacracy in Project Management

Integral Theory brings a strong theoretical base to build Integral Model for Project Management, however it lacks practical applicability. Therefore, Holacracy is introduced. Robertson describes (2007) it not as a model, idea, or theory, but as a straightaway practice. A practice that engages people in, something they do, and something which affects them when they do it – like a sport or spiritual activity that has transformative effect. Unlike weightlifting or meditation, Holacracy is a practice for organizational entities, not for individual humans or even groups of humans – for entities like project management offices or teams. And even though Holacracy does not directly affecting personnel, it can bring a substantial practice benefits that are expressed through them. After all personnel is the muscles for the organization's weightlifting. (Robertson, 2007).

Robertson admitted (2007) that Holacracy as many other practices is difficult to fully understand without actually practicing it. Imagine, reading about dieting and actually trying it – it is just not the same. The feeling and experiences that are brought on each of these occasions are also different. The same goes for Holacracy. (Robertson, 2007).

Holacracy is a very appealing to use for project management as it can align to organizational structure with its more organic natural form, replacing artificial hierarchy with a fractal "holarchy" of self-organizing teams ("circles"). These mentioned "circles" can easily represent project management teams or sub-teams. Each circle connects to each of its sub-circles via double-link, where a member of each circle is appointed to sit on the other, creating a bidirectional flow of information and rapid feedback loops. Each circle organizes itself by defining the roles, which are needed to reach the aim of the circle, and assigning members to fill them. Figure 2 represents how traditional hierarchy can be aligned with the Holarchy (Robertson, 2007).

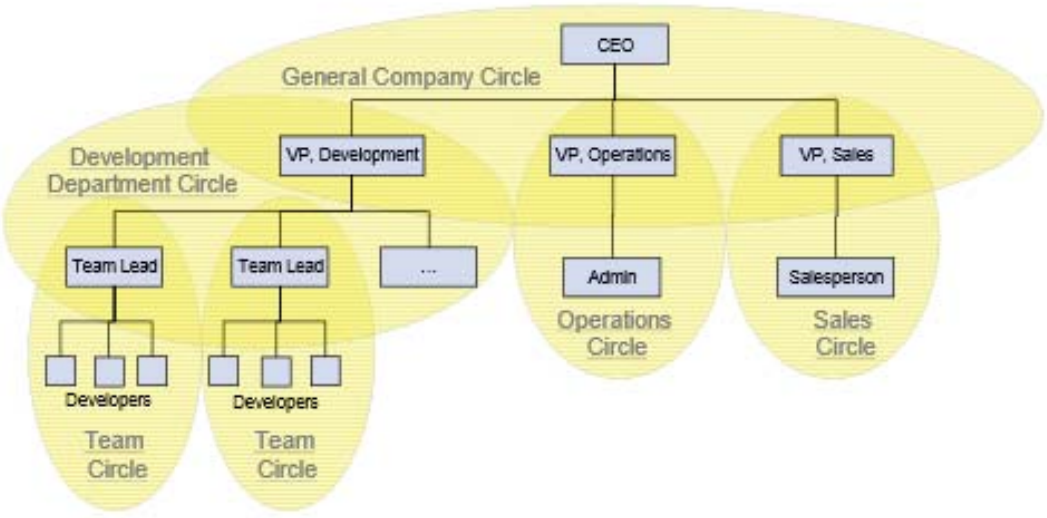

Figure 2. Circle organisation (From Hierarchy to Holarchy)

Holacracy makes organizations more agile by improving the control methods. The focus is on making swift decisions with maximal information. This allows quick and continuous adjustment of the project as new information emerges. In the occasion when it is not really clear what is expected from a team member, Holacracy methods uses empowerment by encouraging individual action using best judgment, accepting responsibility of the consequences and helping organization to learn from the experience. This fits to project management very well, as rarely there is a project that is fully clear and unchanged from the beginning. In addition empowerment brings more involvement from project members and swiftness project execution as there is no need for every small matter to contact project manager. The saved time of project manager can indirectly effect quality and customers satisfaction level as project manager will have more time to focus on the whole picture and project controlling. (Robertson, 2007)

This paper supports Robertson's (2006) view that Holacracy practice would include regular circle meetings. This would help to increase awareness of other "circles" activities and progress, also to see if individual decisions align with goals and requirements of the project. Brief meetings based on Agile methodology are proposed for this model. Agile approach aligns strongly with the Integral Model, as both are orientated to practicality and efficiency.

5. Development of the Integral Model for Project Management

According to the findings of International Centre for Complex Project management (ICCPM) in 2013, traditional project management has started struggling in the face of increasing complexity of projects in today's interconnected world. ICCPM has identified human factor such as social complexity due to political and cultural dynamics as the main barrier to project success. Different governments and corporations form all around the world have started to invest significant resources into understanding causes of the failure and key elements to project success. This research led to an increasing need for new tools and approaches to deal with ever more complex project management (ICCPM, 2013).

To develop a new suitable approach to analyze relevant aspects of project management and increase rate of successful projects, this paper introduces an Integral Model based on Integral Theory and Holacracy. It is believed that holonistic (same entity is composed of parts, is a whole and is a part of larger wholes) and holistic (everything encapsulating) nature can be easily adapted to project management.

In order to be useful, the Internal Model has to be effective, holistic, easy applicable and practical to use in a project management. It has to interconnect different views related to project: organizational-view, management-view, relations-view, individual-view, team-view, stakeholders-view, goal orientated-view and environmental-view.

In 2009 McManus together with Cacioppe took Wilber's Integral Model and adapted it (2011) to suit management and leadership needs. Proposed model (McManus & Cacioppe, 2011) provided a practical approach that highlights the need to think, decide and act with broad perspective, on top it focused on the specific tasks. The model implied that a project manager must tend to both relational (leadership) and task (management) related activities to improve the chances of project success. The model works on both individual (e.g. team member, stakeholder) and collective (e.g. team, organization) levels. This allows to align project manager actions with the culture, vision and strategy of the organisation. It is very important that the model would also have focus on the project goal. After all, the purpose

of a project is the end result. Figure 3 visually depicts McManus and Cacioppe's Integral Model that was build according to the needs of management and leadership in organizations.

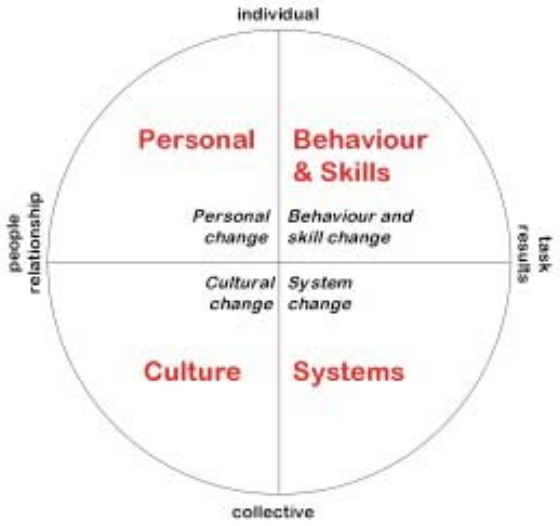

Figure 3. Integral four quadrants of change (McManus & Cacioppe, 2011)

This model is used as the base for the new Integral Model in this paper. A newly tailored model, differently from Cacioppe's and Wilber's model, is 3-dimensional sphere. Additional bi-directional axis is added to provide project with perspectives of improvement and management. Feedback view can be seen as a response or a callback plane (for past, present and future actions), through which system can be tested and evaluated by itself. Feedback Guidance View should be considered as opposing perspective to the Feedback view. It shows the focus on actions, methods and tools to achieve something – may it be project goal, organizational vision, team strength or individual needs. This added axis allows strengthening the project entities uniformly and fills the gap to utilize the knowledge generated from previous projects or project phases as well as keep mind on the potential improvements that could have long-lasting effect, and help in the future projects.

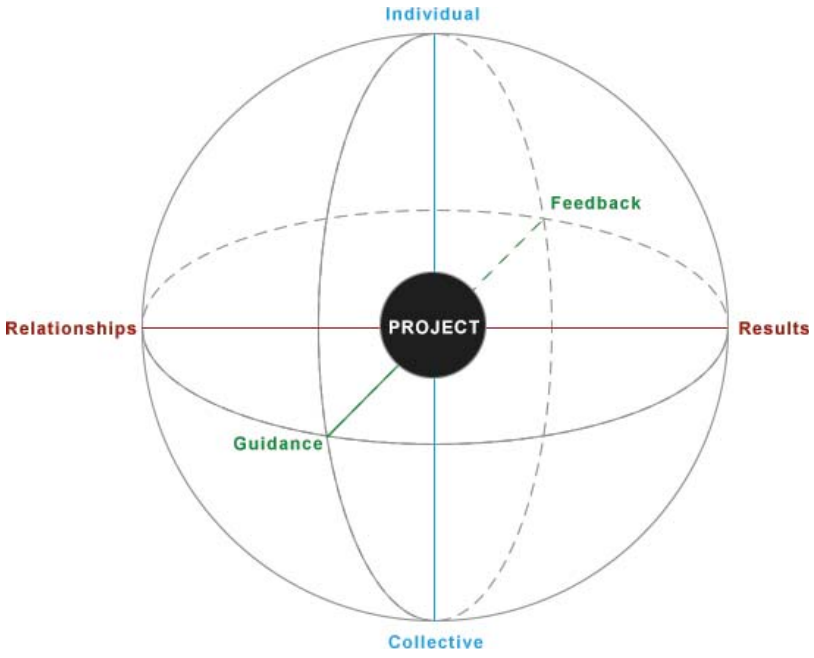

Figure 4. Integral Model "Crystal Ball"

The model can be seen as a "Crystal Ball" (Figure 4) which provides measures to look into the project and analyze it through different lenses (8 quadrants/facets) and different perspectives (6 hemispheres/views).

6. Views of the Crystal Ball

Crystal Ball allows looking at project from all perspectives and includes all bases through the lens of 6 views:

1. **Individual view** integrates single entities that are connected to the project, may it be project manager, team member, team leader, sponsor, owner or customer. It includes both decision maker and decision takers. Individual perspective carries holonistic notion, as entities can be made from parts (e. g. skills, knowledge), be a whole (e. g. person, employee) and be parts of whole (e. g teams, project, enterprise). This view encapsulates values, behaviors, thinking and culture of the individuals.
2. **Collective view** allows aligning project with corporative, collective and organizational model and matching the project with collective vision, culture, structure and environment. Collective view can be seen as a higher (or even encapsulating) holon in Holarchy structure if looked through the lens of individual view (and in fact it is). However, it is important to note that while Holons of different level are rarely put alongside for reflection or comparison (e. g. weight of an atom versus weight of a house) they have direct bidirectional effects on each other (e. g. a weight increase of an atom will directly increase weight of the house). To better understand how this applies to the project, it is important not to forget that, when looked through the Crystal Ball, project is seen also as a holon that is made from parts, is a whole, and is a part of other wholes.
3. **Relationships view** focuses on developing, improving and sustaining relationship between individuals. Pleasant and efficient working environment can be achieved by taking care of relationships on both individual and collective levels. Relationships view also allows to identify, create and sustain collective culture, ethics norms, communication channels and smooth flow of information. Strong relationships between project team participants can strengthen the team and directly improve personnel morale, cooperation, coordination, involvement, integrity, likeliness of project success and image of the company. More solid and transparent relationships will allow individuals to trust more in their peers and in the company, thus resulting in a more relaxed, efficient working environment and faster execution of projects.
4. **Results view** is a very important part of an Integral Model for project management. It allows not to lose focus on the goals. May it be goals of the project, corporate strategy, or individual employees. This is a perfect approach to align project with the strategy of the company. Moreover concentration on the outcome propels development of processes, methods and tools that usually results in an increased productivity, efficiency and profit. Project manager may uses this view to detect project risks and issues at various stages of the project lifecycle, and make preventive actions.
5. **Guidance view** ensures that good management and leadership approaches are not neglected. This view compliments and fits very well together with Feedback view as harmonization and balance between both of them allow not only to identify problems, risk and opportunities, but also develop suitable and reciprocal (Guidance – Feedback) management methods and approaches. Guidance view on a collective level ensures that vision, understanding and directions would match. On an individual level Guidance view becomes significant measurement tool for leadership and management effectiveness. Benefits of this view results in

a more efficient and facile work environment, motivated individuals, effective communication, clearly goal and expectations.

6. **Feedback view** is a hemisphere of an improvement and synergy. This view encompasses approaches, techniques and tools to detect and identify ways to bring evolution on both individual and collective levels. Feedback on a collective level can result in a cultural, system, process and management changes. Feedback promotes knowledge sharing, using previous experiences and building lessons learned databases that can be used in the upcoming projects. It can be used to involve, challenge and reward individual level entities. Feedback should be continuous and bidirectional (management ↔ personnel) process through all of the project life cycle. Project manager and sponsor can use this view to increase their awareness of present and future problems, risks and opportunities, and react on them by providing guidance. Presence of feedback can benefit not only receiver but also the giver by bringing him sense of involvement and satisfaction.

All of the views hold the same importance and should be used uniformly and regularly to achieve maximal effects.

7. Facets of the Crystal Ball

To depict Crystal Ball facets in an understandable way, it is divided into two hemispheres (Figure 5), one from Relationships view, and other from Results view. Each hemisphere has 4 quadrants (facets) where each of them represents an orientation - a sum of 3-views. Facets can be used to identify, detect or recognize areas that have effect on particular orientation or are affected by it.

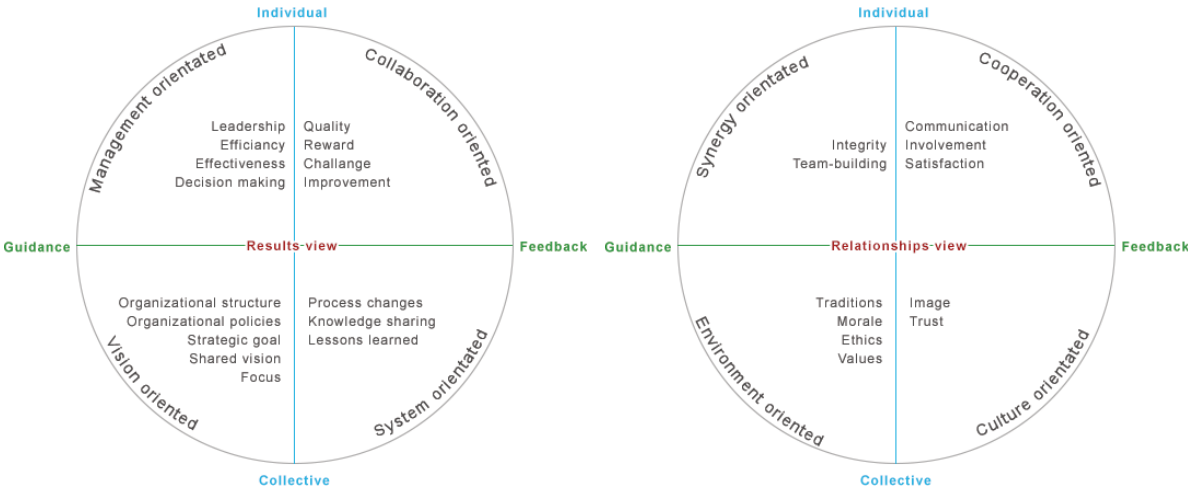

Figure 5. Two hemispheres of "Crystal Ball"

Descriptions below are intended to provide an explication in relation to project management of areas that can be covered by each of the 8 orientations:

1. **Management facet** allows analyzing leadership approaches and checking, if indeed all the methods increase efficiency on individual level. And while there are arguments if project manager should be visible or not. (Kerzner, 2010; Michalopoulos, 2013). This Integral Model encourages to let each individual feel the presence of manager. This can be done through decision making, leading by example or solving

problems. It is very important to lead team members in a way that they would always know what is expected from them and what the goal of the project is.

2. **Vision facet** ensures that project results align with higher organizational structure and structural goals. This higher organization can be corporation, department, super-team (if point of view is from a sub-team) and etc. It also reminds that management should align with organizational policies and rules. Project manager should continuously check if project results will align with the collective vision and expectations.
3. **Collaboration facet** focuses on collaboration between individuals that share a single goal. Project manager should check if there is enough individual empowerment given that would result in feedback. Individual feedback that is oriented to Results view is very important as it is one of the ways to increase project quality, work quality, reward or show appreciation to employees and challenge employees to put effort. As collaboration oriented feedback can be bidirectional (e. g Project manager ↔ Team member) it supports changes and evolution for whole project system. To make it easier to understand, in example, if one of team members will give feedback for project manager on his hard to understand meetings/presentations and project manager makes changes not only the feedback giver will benefit, but also project manager, other team members and indirectly project itself.
4. **System facet** like Collaboration oriented facet focuses on feedback and results, just on collective level. This orientation reflects changes and improvements on a grander scale and not only of present projects but also of past and future projects. Actions done through this facet lead to system development and process changes that focus on growth as a collective: organization, business, team or etc. System orientation promotes improvement, knowledge sharing and changes. For example lessons learned from previous projects can directly affect next ones.
5. **Synergy facet** is orientated in building and maintaining relationships between individuals. Project manager can use this facet to spot tension between team members and take preventive or corrective actions (e.g. team-building, leisure events, changing team-member). It can also be used to identify weak-spots of the team, behavior patterns, or factors that helps team to work. This can be useful for developing teams for the next projects. Stronger synergy between individuals not only makes management easier but also increases competitive advantage and creativity. Synergy benefits derives from combining individuals so that the performance of the combination is higher than that of the sum of the individual elements (e.g. 1+1 more than 2).
6. **Environment facet** allows analyzing and building work environment by combining Guidance and Relationship views on Collective level. This facet puts under magnifying glass areas such as collective morale, norms, ethics, values and etc. These areas can shape relationships and management and be shaped by them. Without numerous benefits of better working environment, it can also result in increased likeliness of project success.
7. **Cooperation facet,** differently from Collaboration facet, focuses on common goals of individuals and not on a single goal. In other words, by focusing on each member's individual needs, project success can be indirectly effected. Feedback perspective allows individuals be involved, increase their satisfaction, and

improve relationships between team members. By working on these three levels, which Cooperation facet covers, communication channels can be maintained.

8. **Culture facet** reflects the trust and image of a collective or a company. Trust and image as all the other areas can be bidirectional – meaning that project team can trust and be trusted by other colleagues. Image is an area that should be taken seriously, as it is very hard to build and very easy to destroy. For a project team that would mean lack of support, worse projects or even unemployment. Project manager can use this facet to identify relationships which are supporting the project and which are not, and as past projects show - support is crucial to project success. (Sutterfield, et al., 2006).

Integral approach suggests that eight facets or orientations have significant importance in a project and must be successfully managed. No facet is more or less important than another.

8. Benefits of the Integral Model

Whether the user of this model does the project in a R&D, medicine, IT, constructions or in everyday life, the Integral Model "Crystal Ball" can increase success of the project by helping to make sure that all bases are touched.

The Integral Model provides universal framework which, depending on the situation, brings different benefits. It acts as a Crystal Ball and it is perfectly normal that different project managers in a different situations will observe and act on different things, while looking through it. An Integral approach ensures that user is utilizing the full range of resources for any situation, with the greater likelihood of success (Wilber, 2006). If the user learns how to spot Crystal Ball views, facets and areas in his own awareness, then he can much easier appreciate them, exercise them, use them and thereby greatly accelerate his own growth and development to higher, wider, deeper ways of being.

Even though this model is created to be applied to project management, because of its holonistic concept (all views are composed of parts, are a whole and are parts of larger wholes) its application can go beyond the project borders, for instance, program management, portfolio management, functional task management. In short, the Integral Model helps user to see both himself and the world around him in a more comprehensive and effective way. It allows keeping focus on multiple areas that directly lead to project success.

Even people that are not using Integral Model, but are in the model's "impact" area can benefit from the effects of this model. For example, if project manager creates pleasant and barrier-free working environment, other members of this environment will benefit at least in terms of easier accessible information.

Crystal Ball is in a way a unique tool compared to other project management tools, because when it is used – it affects not only present projects, but past and the future. Past projects can be investigated through a new eyes, which could reveal previously existent (or still present) flaws in project or project management processes. And future project can benefit from improvements and changes on all the levels (6 Views of Crystal Ball) that occurred during present project. This can be presented as long-lasting effect or evolutional process. Past, present and future projects can also be looked in a holonistic way, and in addition to project, be project phases, project management phases or even programs.

Model works very well together with Holacracy approach and can be easily aligned with lean project management methodologies like Agile. By using Agile alongside, Crystal Ball model has increased ability to harness feedback, adapt rapidly to changing realities, and navigate successfully amidst greater complexity and uncertainty. Integral Model integrates seamlessly with agile methodologies and fills in the gaps in process control, feedback and decision-making systems that are directly not addressed by the most agile methodologies (Robertson, 2006).

Crystal ball model shines when used in self-organizing teams, where uncertainty and project complexity is high. Therefore, the Integral Model is a powerful addition to project management environment, where it can be practically used in an effective way.

9. Challenges of the Integral Model

The Integral Model is a powerful and universal tool, however all these benefits do not come without drawbacks. Self-organizing, high agility and holistic nature are the challenges in itself. Robertson agrees (2006) that self-organization brings too much autonomy at one level of scale and this destroys the ability to self-organize at a higher level of scale. For example, when an agile software team has full autonomy in the name of self-organization, that can actually hinder the ability of the broader business-level or department-level holon to self-organize at its level of scale — the team is a part of it, and it needs to be able to exert some control on its parts to achieve its own self-organization. This is often the concern seen around self-organizing teams — upper levels in the organization also have needs to control their parts. However, the need for control is only a half of the story. “The benefits of self-organization are also lost if a higher-level holon dominates its parts and interferes with their own self-organization. That effectively destroys the lower-level holon’s wholeness and puts all of its complexity on the higher-level holon’s doorstep.” (Robertson, 2006, p. 1). The challenge of whole systems self-organization can be solved by double-linkage that is proposed by Robertson (2006) Holocracy theory and is not covered in this paper.

Also, as the Integral Model is based on Ken Wilber’s Integral Theory and Robertson’s Holacracy, Integral Model can inherit their strengths as well as their weaknesses.

Finally, a drawback can be the complexity and holistic nature of the Integral Model, as it covers everything and on many different levels, it is likely that in an inexperienced user hand the model will not be fully utilized, but with practice this may be easier to overcome.

10. Application of the Integral Model

As mentioned earlier, the Integral Model should be used continuously and in a project environment its use should be aligned with project management phases and processes. Model should be a compulsory addition to every meeting as this would allow stronger insight in to the project and should make meetings more constructive and beneficial. Meetings (circle meetings, scrum meetings) are good environment to use Crystal Ball, as it makes easier to grasp Collective view there.

The Integral approach suggests that all the facets and view hold the same importance, therefore if project manager is encountering any problem (e. g. time delays, cost overruns, safety, mistakes, complaints, etc.) that occurs during a project, must apply an adequate quadrant if he is to properly identify, understand and solve that problem. The Integral Model also provides a lens through which a project manager may view project risks and problems at various stages of the project lifecycle.

As demonstrated in Figure 6, the level of effort required during the lifecycle varies. The more effort is put in each phase, the more Integral Model should be used. This is important because it is not only the level of effort required that changes over the lifecycle of project, but also does the number of issues. Therefore, a comprehensive approach to project management that works in a holistic will provide a greater degree of success. The integral model has broad focus and includes the broader vision, purpose, strategy, culture, leadership and feedback required to deliver the project. (McManus & Cacioppe, 2011)

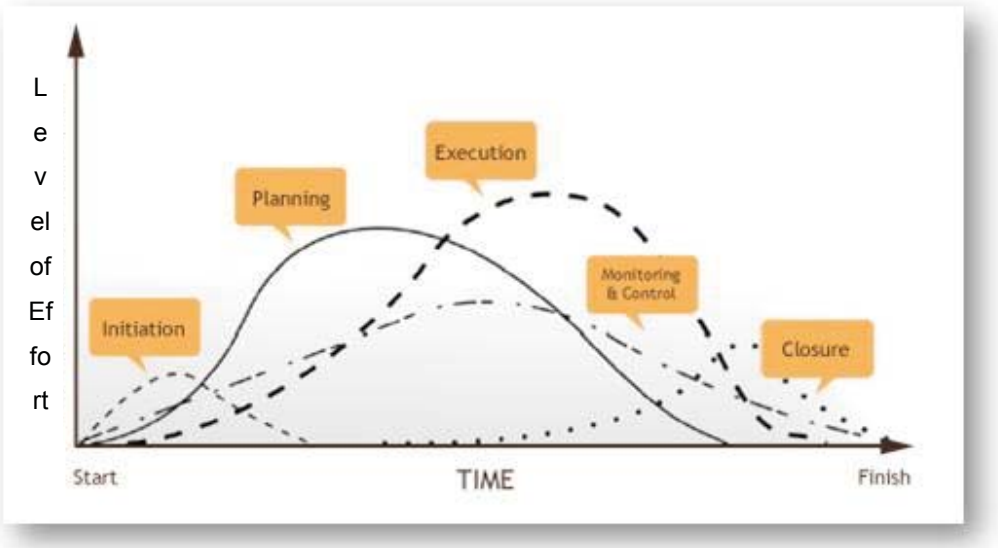

Figure 6. Project Management Life Cycle (Project Management Institute, 2013)

11. Conclusions

Developed Integral Model is a combination of agile methodology, project oriented Integral Theory and Holacracy, where Integral theory encompasses everything and syntheses the best of pre-modern, modern and post-modern realities (Esbjörn-Hargens, 2010). In addition, Holacracy brings system elements that distribute authority and decision-making to self-organizing and evolving teams (Robertson, 2007).

This Integral Model provides a tool for project manager to increase projects success rate by revealing projects from 6 different perspectives. With the help of this Integral Model, a Project Manager can improve project management due to greater opportunities to:

- cover all project bases
- increase efficiency and quality
- detect and avoid risks
- identify, prevent and solve issues
- grow on a professional (e. g. project manager) and personal (e. g. friend) level
- reduce decision-making time
- improve working environment
- raise team members satisfaction
- develop project team
- shape organizational and project system
- relate experience from past, present and future projects
- have a long-lasting affects
- build positive image

All quadrants of the Integral Model hold the same importance and must be used uniformly. It is recommended that the frequency of use would align with the effort level in different project phases. The Integral Model should be considered as a lens or Crystal Ball through which project manager can gain deeper insight in to the project management and project environment.

12. Limitations

While looking for existing integral models that could be applied to project management, plenty of scientific articles were found. On the other hand, it was also noted that research has still not solved current project management problems (Standish Group research 2013). With regard to such a huge variety and questionable practical value of previous research, there may be a limitation on proper models selection to develop the Integral Model for Project Management.

Also, this Integral Model is based on other models such as Ken Wilber's Integral Theory (2006), Brad McManus's & Ron Cacioppe's Integral Approach for Project Management (2011) and Brian J. Robertson's Holacracy practice (2006). Since the reliability of the Integral Model has not been tested yet, it depends on the reliability of these other models. According to this, there may be some limitations with regard to the reliability of the entire new Integral Model.

Moreover, this Integral Model does not have any measurement scale that is likely to relate the Integral Model application to the rate of project success.

13. Further Research Questions

To overcome the limitations of the Integral Model, there are some questions for further research. Firstly, it would be useful to find and assess other existing integral models that may be incorporated if further research on the Integral Model is done.

Secondly, to check the integrity and reliability of this Integral Model, further research should be done, while feedback from Integral Theory experts and practitioners should be collected. Basically, to increase the credibility of this paper, the Integral Model should be tested in practice. The best approach could be to let different project managers use the proposed Integral Model in different organizations with different structures and various project

sizes, and then do a survey to identify effectiveness, strengths and weaknesses of this model. Survey would help bring more scientific and practical value to this research.

Finally, the Integral Model could possess more reliability if measurement scale was introduced in further research. This would evaluate the impact of Integral Model application on the rate of the project success in tangible units, for instance, time and costs.

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Understanding collaboration needs within the communities of practice that form tyntec

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Keywords: team cross collaboration, technology stewardship.

Abstract: Communities of practice are different not only for their specific "practices" but also for other several aspects like the form they interact, constitution, necessities, and evolution among others. These elements actually define the manner groups behave themselves and with others in terms of exchanging information, creating knowledge and collaboration. In order to understand the needs of a specific community of practice in this sense, it is important to fully seize the background and characteristics that more address and identify them. In this way, proper decisions can be made when selecting the tools that satisfy those needs. On top, it opens a door to identify the missing points or failures that they might have when collaborating, since a full picture is taken to be compared with the goals of a specific community. Technology stewardship is a concept proposed by Wenger E., in their book Digital Habitats, of analyzing characteristics of communities of practice in terms of knowledge sharing and collaboration which allows identifying the collaboration needs and selecting the tools that could fit better the requirements of each community of practice. This methodology is being applied in a research project called The Network in tyntec in order to identify clear dysfunctions among teams concerned to communication and collaboration, so that, future decisions can be taken when selecting the tools and platforms that its teams use for their daily work.

1. Introduction

Nowadays collaboration is well spread term in companies. It gives the sensation of people working together in cooperation. It is also a trendy term generally related with innovation which can bring an organization to the next level. Carlos Dominguez in a Cisco blog describes Collaboration as "highly diversified teams working together inside and outside a company with the purpose to create value by improving innovation, customer relationships and efficiency while leveraging technology for effective interactions in the virtual and physical space".

Collaboration is in essence a process of creating value, which involves the use of technology and the people who utilizes it with this purpose. It also addresses the fact that people do not need to be in the same place in order to be collaborative. But how is it handled within the organizations? How do teams interact with each other? How could this be improved? What type of "dysfunctions" can be found and how can this be measured? Moreover, what type of technology would actually fill the collaboration needs for a specific group, team or community?

tyntec is one of the organizations that is asking these questions. As a company that needs to be highly collaborative due to its location in two main distant places (Dortmund and Munich), it is its will to comprehend how their teams are working together in cross collaboration, what their needs are currently,

what are the gaps between the current state and their needs as they evolve in order to share information and create value. Being aware of these aspects assures proper decision taking when selecting new tools or platforms or restructuring the processes within the organization.

To be successful in "effective collaboration" three important aspects should be considered: the culture, the adoption of processes and the use of technology. Etienne Wenger and Nancy White, in their book "Digital Habitats: stewarding technology for communities", propose a full methodology which includes from identifying characteristics of what they call "communities of practice" in terms of maturity, diversity and tolerance to adopt new technology, to the point of choosing the proper tools and platforms that could best fit the needs of those communities.

As they suggest, each community of practice, or in this case, each team in tyntec behaves differently. They have different activities, processes, level of maturity, constitution, goals; therefore the way they collaborate may vary from one to another. More important, their needs are different. So as to define properly what the communities of practice contained in tyntec need, it is relevant to study deeply their characteristics before jumping into selecting the tools.

Since the technology can define how a community of practice develops, selecting it is something to consider carefully. This is why it is important first to understand the community, its behavior, characteristics, needs and then go to the technology that fits better the condition of it.

2. The Network project in tyntec

Currently tyntec is working on project called "The Network" which mayor aim is to draw a map with the teams that live inside of the organization and their interconnections as "collaborative links". It would lead to identify the possible missing connections, dysfunctions and main characteristics in information sharing, communication and ultimately cross collaboration that are carried within the organization.

This data is gathered by applying the first part of the methodology proposed by Wegner and White when performing "technology stewardship", which means taking a perspective from the community with the purpose of **helping, selecting, configuring and using the technologies that best suit its needs**.

The goals of the project are:

1. Understand the current way teams and cross-teams interact
2. Identify the collaboration needs of these groups in relation to their profile
3. Find out the perceptions of groups on improvements in this context

The idea is to gather enough and useful data to describe the current situation of each team, conceive how, why and to whom they are connected to and visualize how they could possibly evolve to a target condition. This last "target" part is based on suggestions and considerations of the team members. By having two perspectives of the team characteristics, one in the present with the current status and one in the future with the target condition where the teams would evolve, it would facilitate the identification of gaps and possible needs of the teams. On top of that and after analyzing those collaboration needs, further recommendations can be provided to improve their communication channels, implement possible "upgrades" to their current processes and hence, ease collaboration.

2.1 tyntec team's characteristics

The first part of this study is about understanding tyntec team's characteristics. As Wegner and White propose, three important elements can be considered when collecting data:

- Lifecycle: is about the finding out the maturity of the group, in what phase of constitution as a community they are. They could be "Just forming", so they could just only need a few and basic tools to connect as for example E-mails. Or they could be on a "Self-designing" stage, just gathering information, which means that they know what they want. Or perhaps they could be "Growing and restless", ready to add a new tool or platform to their configuration. Or finally, they could be in a "stable and adapting" period, where just some new tools are needed. By finding out how much time they have spent together, could be possible to get how mature the team is regarding collaboration.
- Constitution: this element considers the cultural and logistical diversity of the group, including time zones and languages. Also it takes into account the openness of the group to be connected to the outside world, as well as how much privacy, security and interaction with other communities is needed. In order to narrow the scope of this study, this part would be more focused on the variety of roles and locations (remote, home office, in place) where the teams are.
- Technology aspirations: it is about looking for the tolerance and skills when using new tools or platforms. It also considers what constraints they could have when doing their work in terms of connection and availability. The idea is to catch that if they are willing to give up with some tools, are they also willing to adapt a new one? How hard could that be? Some teams like Development could be more tolerant to change to better tools if necessary as they are more in contact with technology than others. But it might not be the case for other teams which could be probably more blocked when using new technologies.

2.2 team orientations

An important part of the study is "the team orientations". This is the probably the most representative and valuable information of this research. By pure definition from the book Digital Habitats: stewarding technologies for communities, an orientation is "a typical pattern of activities and connections through which members experience being a community". It is a specific characteristic that stands out in the team in order to be collaborative. In another words, it is an element that makes the team alive and without it could not produce value. The nine orientations suggested by this book are: meetings, projects, content, open-ended conversations, relationships, individual participation, community cultivation, access to expertise and serving a context. All these orientations are considered key points where value is generated, thus collaboration. Each of them can be performed differently or in more or less level from team to team.

Within the context of this research orientations can be described as following:

1. **Meetings**: they are a key activity in tyntec. Meetings are really often in all of the teams and could be face to face or on line through video conference, synchronous or asynchronous. To what extend meetings matter for the teams, what type of information is shared, how they could be improved. It could be that the same value can be generated through other channels or, in another hand, a recommendation for requesting more videoconference rooms could be made.

2. **Projects**: besides the projects team, some teams in tyntec are handling their own internal projects. An analysis in this orientation is made in order to capture its level of importance for each team

and how well prepared they are to do so in terms of planning, coordination, scheduling and identify some possible points of improvement.

3. **Content**: how the content is created, shared and store is something also to be analyzed. All teams generate different type of content as they are different practitioners, but the aim is to take in how much it matters to them and describe how they do it. Also it is interesting to consider privacy or security settings that the teams are handling within this orientation.

4. **Open-ended conversations**: value could be generated in either one or multiple topic conversations, either by a simple chat talk in the kitchen drinking coffee or within a chat room. How much value is created in the teams in this sense? Are these conversations store afterall? Is it something important for tyntec's communities?

5. **Relationships**: value is also generated through informal relationships, for some teams this aspect could be more developed than in others and encouraging this orientation could end in effective collaboration when having the right tools. How much it matters for the teams and how spread is this orientation?

6. **Individual participation**: it is about how each member put their part, individual contribution. It reveals the importance of each member's autonomy and independence to deliver value. Besides, it describes the way they do it, do they add their own personal style to their work?

7. **Community cultivation**: do the teams have their own identity or personality? Do they care about implementing their own policies to preserve this identity? What type of steps they consider in order to do so? And regarding tyntec's identity? To what extend they perform it? Collaboration can be improved when teams have their own internal branding, vocabulary and personality.

8. **Access to expertise**: in order to generate value, teams would need the help to special consultants within or outside the organization. The aim is to evaluate how much this is done and through which channels, furthermore, how could this be improved as well.

9. **Serving a context**: within the context of this research, this orientation is called "cross collaboration". It means that value is meant to be shared with other teams; in view of they taking it to generate their own value. The aim is to understand to what level. It is the most meaningful orientation because it will permit building the network once the connections to other teams are identified. Questions like what type of resources are used with this purpose, how important it is and how could this be improved, are key in this part as well.

After a deep analysis these orientations are measured in a scale from 1 to 5 in both current and target status and then be displayed in spider charts. This is a powerful tool which graphically shows in one place to which orientations teams are addressed the most, as well as the gaps towards what is currently in place and what they would like to achieve.

2.3 Technology configuration

The last piece of the study is to obtain a list of tools that are used of each in order to create a list and figure out how they are used, for which intent and their key features. In that way, the "technology configuration" of each team can be analyzed as well.

All the information is gathered by interviewing and having conversations with members. A deep analysis is performed by the project team in charge with the intention of grasping how the teams are doing collaboration, address their needs thanks to the identification from the orientations point of view and come up with possible recommendations to the management team.

4. Conclusion

The results of this study can be used then for future research projects within the company when performing the full concept of technology stewardship. Understanding how the communities of practice contained in tyntec: teams, departments or focus groups use their technologies, helps to identify issues and dysfunctions in the way they communicate and collaborate. Counting with enough information enhances the decision-taking process towards the selection of proper tools that fits better the needs of tyntec in this sense. Analyzing how these communities interact with each other also allows building a network: a map of connections that shows how strong some links are, as well as some dysfunctions. It could potentially address the weak points where communication and collaboration can be improved. Furthermore, it finally stands for the principal needs of each team, which shows the overall view of tyntec's needs. The challenge is now how to fulfill those needs.

5. Resources

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ISO 9001:2015 and PMI PMBOK v5: Analysis of revision changes and future requirements for quality management in projects

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Abstract: This contribution will focus on mapping out the probable changes to the future ISO9001 version, some of the connections with the 2013 revision of PMI PMBOK Fifth Edition as well as possible outcomes from this interaction as requirements relevant to the future shape of ISO10006.

ISO9001: 2015 Revision: Scope of change and areas of impact

The International Organization for Standardization (ISO) is working since 2010 on a new revision of its international standard for management systems– ISO 9001- which is currently being used by more than 1 million organizations and individuals in over 170 countries[4] and is considered to be the foundation of all standards related to the field of quality management.

ISO 9001:2015 is expected to be officially released towards the final quarter of 2015[5] and will replace the current 2008 version. The standard was first introduced in 1996 and its last big revision was undertaken in 2000, which means that serious considerations about its actuality and realignment to new market realities and demands after more than 10 years are long overdue. ISO standards development involves a 6 stage process and presently ISO 9001 has just reached stage 4 called Draft International Stage (DIS)[6]. At this stage any interested parties can submit feedback regarding the draft version to the ISO technical committee in charge of revising this standard via their respective national member bodies. In stage 5 all the comments received from around the world will be considered and final changes made to the document in preparation for its official release (stage 6).

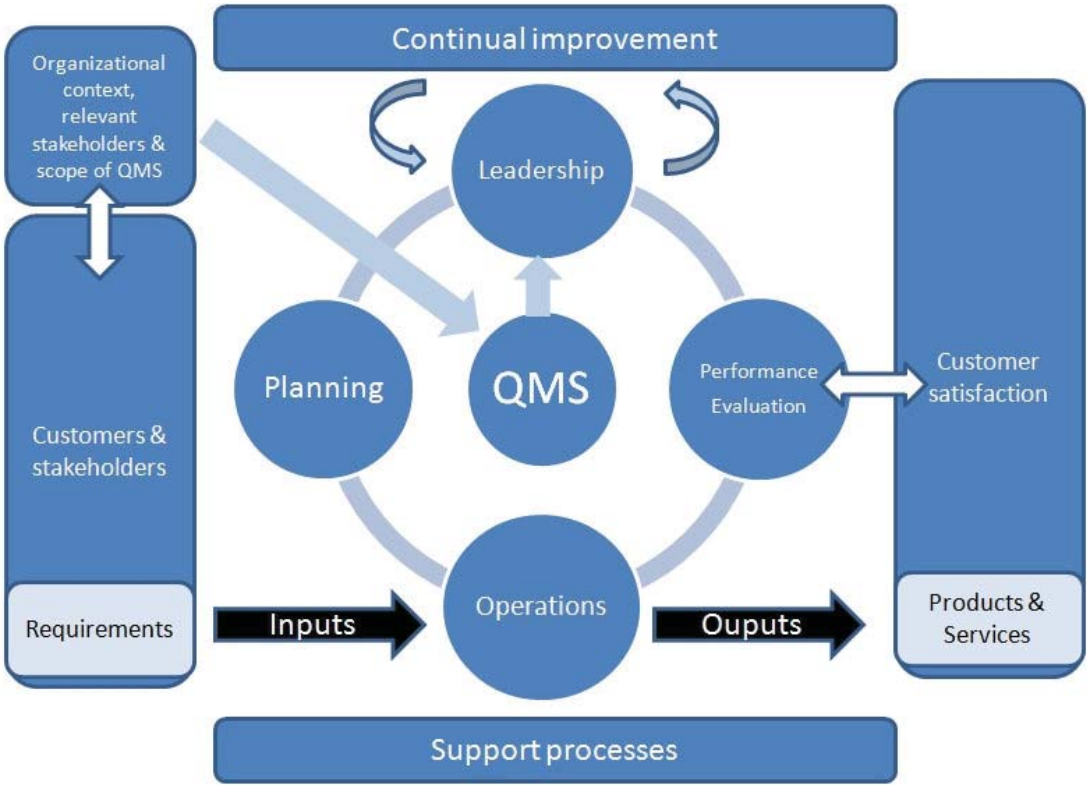
The current revision is shaping up to be not only an improvement on the existing version, but a serious change for the entire ISO 9000 standards family. Up to 40% of the existing content is expected to be revised[7]. These changes will have an impact on quality management across business sectors and fields of practice worldwide. For instance, Annex SL provides a new top-level structure for ISO 9001 which will probably be incorporated into or at least considered for consistency for all future family standards[1] including the future version of ISO 10006:2003 “Quality management systems -- Guidelines for quality management in projects”, which has reached its periodic review stage with ISO/TC176/SC2 and is expected to be updated within the next few years.

Basic approaches of the new DIS9001:2014

Stakeholder management: The stakeholder value approach was previously only anchored in ISO 9004 but has found its way in ISO 9001 now as well[7]. Ch. 4 deals with how organizations handle their socio-economic environment, especially identifying and managing requirements and expectations of interested parties.

Leadership: Top management will have to demonstrate more engagement as well in the future as there are additional requirements for leadership qualities of managers. A recurring theme throughout the standard will be establishing a clear connection between policies, quality management and core organizational processes. The future ISO 9001 will call for increased responsibilities in in all business areas: communication, alignment with organizational strategy, quality policy, change management, risk planning and customer focus to name just a few[1].

Process Approach: The process approach will have increased importance in the new version as process management will be regarded as the main instrument for generating successful business. ISO 9001 will feature specific requirements for inputs/outputs descriptors, risk assessment, key performance indicators and process ownership[1]. Furthermore, there are requirements for alignment of company policy, strategic objectives and core business processes where the PDCA cycle has been designed to be fully embedded, as shown below.



Source: based on DIS9001:2014[1]

Risk Based Assessment: In the context of DIS9001 the concept of risk is related to the uncertainty in achieving the main objectives of the standard: to provide a framework for organizations to consistently deliver conforming goods and services and to increase customer satisfaction. [9]. As such, organizations are encouraged to actively manage opportunities and

risks, yet the DIS9001 explicitly states there will be no requirement for a formal risk management or documentation[1]. The standard will provide a description of how risk management is to be integrated in the organizations business processes: in clause 4 the organization is required to determine the risks which might impact on its ability to deliver quality outcomes, in clause 5 top management commitment is required to make sure the previous clause has been met. Clause 8 addresses risk related to company operations while clause 6, 9 and 10 address the risk management process components of planning, evaluation and improvement[10]. There are requirements for internal and external risks and opportunities to be addressed in all areas of an organization keeping in mind however that the costs of risk management not exceed the potential gains.

Information and Knowledge Management: ISO 9001 will strongly emphasize the importance of managing information and knowledge processes. There will be requirements for organizations to continually assess their knowledge needs in order to support business processes and cover eventual knowledge gaps from internal or external sources as deemed fit[1]. The standard acknowledges that organizations should have mechanisms in place to systematically capture lessons learned, undocumented knowledge and experience. People are identified as the source of competence in the organization: the standard will state requirements for identifying necessary competences in order to achieve quality objectives and for providing training where required or acquiring the necessary competence from outside the organization.

The following table provides a brief overview of the expected chapter and content changes:

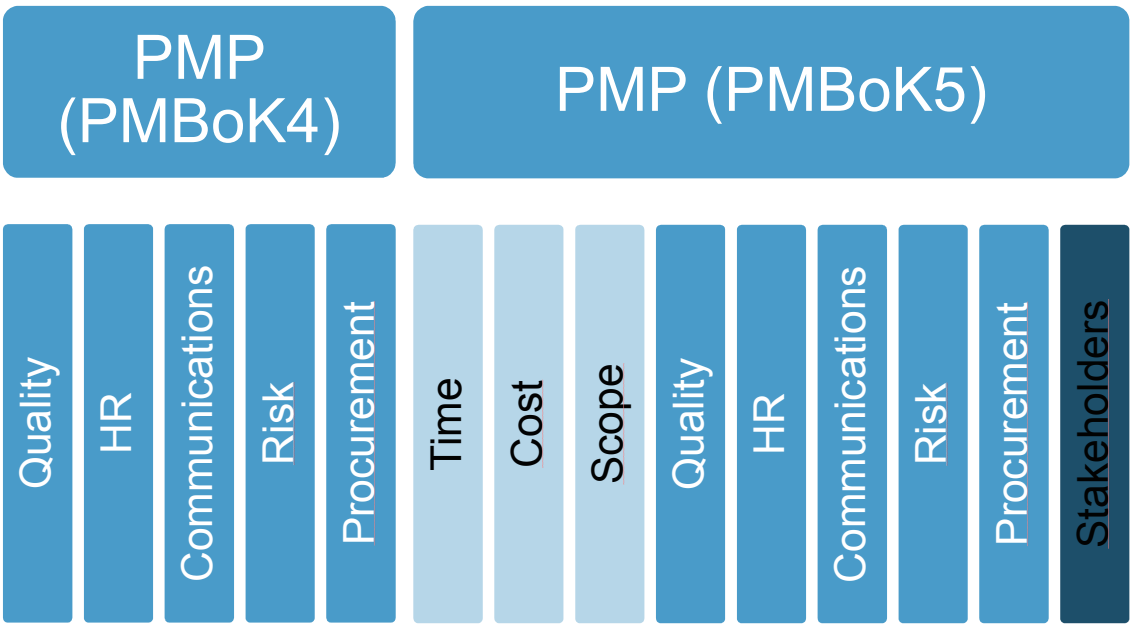
Ch.	ISO 9001:2008	Ch.	DIS9001:2014	New Content and Structure
4	***Quality management system***	**4**	***Context of the organisation***	- context - interested parties - scope of QMS - quality management system
5	***Management responsibility***	**5**	***Leadership***	- management commitment - policy - roles, responsibility and authority
		6	***Planning***	- actions to address risks and opportunities - objectives and plans to achieve them - planning of changes
6	***Resource management***	**7**	***Support***	- resources - competence, awareness - communication - documented information
7	***Product realization***	**8**	***Operation***	- operational planning and control process - determination of market needs and interaction with customers - control of external provisions of goods and services - development of goods and services - production of goods and provision of services - release of goods and services / non conformity
8	***Measurement, analysis and improvement***	**9**	***Performance Evaluation***	- monitoring, measurement, analysis and evaluation - internal audit & management review
		10	***Improvement***	- Non-conformity and corrective action - improvement

Source: based on ISO/TC 176/SC 2/WG23 NO 63 [9]

PMI PMBOK 5 Revision: Changes and new approaches

PMI has made some efforts to bring the PMBOK series a step closer to ISO and align it with any other PMI standards such as those for Portfolio and Program Management[3]. It has also been aligned with the new ISO 21500:2012 "Guideline to Project Management" and the "PMI Lexicon of Project Management Terms". Additionally, old Chapter 3: "The standard for project management" has been moved into Annex A1 as a standalone document in order to prepare the release of the ANSI/PMI 99-001-2013 standard[2].

After removing content into Annex A1, Ch. 3 has been focused on the processes and process groups and strengthened by new business rules to ensure consistency in handling information in the Inputs, Outputs, Tools and Techniques areas of each process which also include new rules for project documents and project management plan (PMP)[3]. The PMP will include the 5 traditional documents (quality, HR, communications, risk and procurement management plans), but also for consistency time, cost and scope management plans and additionally the stakeholder management plan[8], as shown in the figure below.



Communications Management has been split and focused on collecting, storing and disseminating project information as well as monitoring project communication activities. In order to add clarity regarding project data and information flows, the terms of work performance data, information and reports have been redefined[3]. PMI has also adopted the Data-Information-Knowledge-Wisdom knowledge management model to better distinguish the different grades of complexity of different knowledge artifacts within a project.

There is one additional knowledge area resulting from the split of the section on "Project Communications Management". This is due to the acknowledgement of the importance of stakeholder management for the success of projects. The new knowledge area emphasizes that project managers should not only analyze stakeholder interests and react on their behavior but to actively and continuously engage them over the course of the project and gain their support[3].

Ch. 1 contains a new section on the role of project manager as well as the interpersonal skills needed in this profession and is connected to Appendix X3 which describes some of these skills in further detail. Leadership, team building, social and political awareness are just a few of the features to be balanced for the effective running of projects.

Impact of changes on future standards development

Very much like ISO, PMI recognizes the importance engagement from the upper echelons of management has towards securing sustainable and lasting business success, and is moving to align PMBOK with ISO contents. This might mean for future developments of ISO and PMI standards that there be increased requirements to demonstrate ability to consistently align organizational strategy (including portfolio, program and project management), quality objectives and processes and to be able to make these connections visible inside and outside the organization.

There have been some timid steps so far towards creating more effective communications, information handling and acknowledging people as a collective source of knowledge the organization can draw upon, however, there have been few considerations so far as to how to provide an adequate social and technical infrastructure that fosters knowledge transfers within the organizations. Perhaps the future ISO 10006 should address these issues by providing some guidelines on how to create a culture that enables change and facilitates knowledge sharing, policies for open and honest communications, etc...

It would seem the idea that different interests need to be acknowledged and actively managed in order to ensure the success of a business is finally, gradually taking hold again. Shareholder value used to be the preferred approach of the 80's and 90's, but with rising international trade and emergence of social media, organizations find themselves under increasing competitive pressures as they often have to face public scrutiny and sometimes criticism. This is definitely one of the key areas of focus in the ISO 9001 that needed some revision after such a long time. Organizations worldwide should be prepared to give account about sustainability and public support of their operations, as generating consensus by engaging and involving stakeholders inside or outside the organization might be one of the keys to future business success.

Risk based thinking is a central theme of the revised edition as considerations on handling risks and opportunities have been embedded in every step chapter of this standard. However, due to the lack of requirements to document risks and also vague phrasing related to the measures to be taken we feel this basic approach to be lacking in strength. Managers will have to rely on their own judgment and experience in choosing how formal and explicit their organizations' risk management plan should be.

Overall we can observe that so-called "soft factors" are currently dominating the agenda of standards revision: stakeholder engagement, demonstrating leadership, effective communications and information management. However, we can also acknowledge that steps taken in these areas are still small and that there probably should be further considerations on these topics in future standards. As far as ISO 10006 is concerned, an integrating section on organizational/project culture and how to promote risk awareness, knowledge sharing, effective communications and process based thinking would probably constitute a welcome addition.

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Political Economics and Project Management as its gear box to Business Administration

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1) Introduction

Economical science is divided into two main parts. Political Economics tries to understand and influence the general framework of economy in a country like customs, governmental influence, national income, welfare, inflation etc.. The Business Administration is an "egoistic" Science for companies: how to be better than the competitors, how to gain profits, how to grow and sell more goods etc.. Political Economics tries to reach prosperity, welfare and high employment via a suitable surrounding for companies and individuals to gain taxes, employ people and supply markets.

But how the one (Political Economies) influences the other (Business Administration) in reality to reach their targets? What happens if the tax rate will be reduced in order to achieve political targets like growth? What happens if the national interest rate is reduced by the national bank to achieve a higher rate of investments and more employment?

The answer must be found in the new, additional, expansionary business. New investments lead to prosperity and employment. To move the economy in the country to the mentioned goals needs sustainable changes and business development in the companies and this is based on new projects because if nothing new will happen any ambitious target will be achieved. If this project implementation happens not only in one company but in hundreds it is possible to achieve the needed effect in the economy of the country. And we have to understand that companies cannot be forced to perform investments and projects – they make their own decisions namely in projects. So we have to understand the decision making process in Project Management. And this means we have to look to the tools of Project Management if we want to see explicitly, where the lever of Political Economics has to be applied.

The article will start with an overview and a limited collection of tools in the field of Political Economics. Than the main tool of decision making in Project Management – Net-Present-Value (NPV) -Method - will be introduced shortly in general and in one example to show how decisions happen in practical life. The next chapter will show the function of the NPV-Method as a gear box between the incentives coming from the Political Economics and decisions in the companies - all this

to achieve finally the political targets in the country. It will be shown that the awareness of project management is crucial for the success of Political Economies in a country.

2) The toolbox of Political Authorities

The toolbox of political authorities to influence the economy in a positive way can be various. At first the general frame of economy has to be defined – does the country relay on market power or better on bureaucracy or state-directed economy [2, preface; 21, p. 158]? Most of the countries decided to use the power of free markets. But exactly this than reduces the direct impact of political power because the companies than will act independently. The next step in political economy is to create "a reliable surrounding of business" like a functioning and quick court system, fighting against bribe, allowing and supporting internet based business, giving a modern and simple legal framework for contracts and patents [15, p. 71] and so on. One next step can be done by the authorities itself: they can invest more on their own and try to increase the volume of business by these own activities [3, p. 130]. We know that this might lead to conflicts with high level of debts and based on this even might lead to an economic and political crisis.

Here we focus on instruments which are related to investors and have the background and target of prosperity like growth, high employment rate and price stability. We don't distinguish between a whole frame of political targets based on strategies and long term goals or whether we observe punctual "quick and dirty"- actions. The six best known instruments are described in this chapter.

2.1 Grants and Subsidies

This area is chosen first because it is the best known and easiest way to influence the economy. Subsidies are given directly to companies in order to achieve concrete targets which have to be fulfilled by the requesting companies (conveying coal, reducing pollution, support of underdeveloped or destroyed regions). Subsidies do not include the duty to pay them back. As an example: Germany will give subsidies in 2014 in the volume of around 22 billion Euro [21, p. 12].

2.2 Reduction of Taxes

Tax reduction has the same target than subsidies – instead of giving money to the companies it will "not be taken" from them. [13, p. 60; 3, p. 129 and 133] For example in April 2014 German State Secretary Zypries announced in the TV-News, that tax reductions will be given to start-up-companies and risk-taking companies in the field of new technologies.

2.3 Pledges and Guarantees

These instruments are often used by the state to guarantee to companies the risk of missing payments from customers abroad. In 2012 Germany guaranteed to German firms a level of almost 30 billion Euros. Contracts to Russia and China were the biggest part with the amount of almost 5 billion Euros. [9, p. preface]

2.4 In Price reduced Loans

For a wide range of occasions the state offers loans with cheapened interest rates in relation to the market rates. If you build new houses, found companies, invest abroad or in education, reduction of pollution or saving energy: check at first if you might get a cheap loan from the state or state owned organisations! [12, p. 393]

2.5 In Price reduces Labour Costs

For special branches, groups of employees, regions, groups of unemployed people or overemploying employers the state might offer financial benefits to give jobs in a short or long run to people. [22, p. 194]

2.6 Speeding up of Depreciation

Depreciation amongst others has the aim to “pump” the investment volume to future profit and loss accounts to reduce tax burden. The allowance of faster depreciation [22, p. 198] allows in times of constant tax rates profits in the field of interests – there is no real tax reduction. So it is a soft instrument to fasten depreciation but has the advantage to be adjustable to certain concrete investments. It is applied for example to investments in protecting the environment, hospitals or small companies. [5, §, 7 d, f, g]

3) The NPV-Method

The Net-Present-Value method is a “Money”-picture of a project in the time dimension “future”. So all impacts and outflows referring to a project are covered by this picture and one can condense this picture finally in an essence of one figure – the NPV. Is the NPV above zero you should execute the project – if NPV is below zero you should leave it.

The core of the NPV method is that the cash flows at different times have different values [7, p. 9]. Cash flows at different times cannot be compared directly but with the help of the NPV method all cash flows of an investment can be converted to a set time “t” and the values can then be compared or even added. Normally, this specific time is "The Today" with $t = 0$ in order to provide the decision-

makers an indicator for the decision as simple, current and realistic as possible. The formula for calculating the net present value (NPV) is generally as follows [7, p. 13]:

$$NPV = \sum_{t=0}^{N} \frac{C_t}{(1+r)^t}$$

To add the world of taxes to the system – to be more realistic - we add a line of negative Cash-values "taxes" on the one hand. On the other hand we adjust "r" to the level of "r minus taxes" to take into consideration the tax burden on alternatives as well.

The NPV can be interpreted as an additional value contribution for the company by the new project (added value). If your company has the opportunity to perform a project with a positive NPV you should add this project to your company/portfolio, because by implementing it, the value of the company will grow. [For further details read 23, p. 1 et seqq.).

Chapter 4 will show the impact of political decisions to company's decision. To make this possible we create one model case of a NPV calculation and then show the impact of political decisions in the six areas shown in chapter 2. The author dealt in his business career as head of controlling and CFO with hundreds of NPV calculations – most of the cases can be described as follows:

- The cash stream starts with an investment - so a negative cash out - in the beginning (power station, implementation of software, marketing campaign…)
- Additional costs are caused year by year by the investment like labour costs, insurance, material, energy
- Revenues of this investment are gained in future like from selling new products, getting savings or additional sales volume
- The discounting rate is a weighted average of own and credit capital costs
- The project has a start and an end – covered by the considered time line
- Taxes have an impact on the volume of the cash (tax payment) and the discounting rate (taxes as well on alternative investments)
- Risks are covered in various ways (price for a hedge, to include probabilities, insurance, calculation of alternatives…)

All these points are covered in the following model case of an investment with a NPV in this example of around 1 Mio. The details of this model case are just devised as examples and can be seen in the next table – a currency is not needed to be defined.

General data

discounting rate before tax	0,058
tax rate	0,314
discounting rate after tax	0,040

Capital data

	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,04

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9617	0,9249	0,8895	0,8554
Investment	-8000000				
labor costs	-900000	-900000	-900000	-900000	-900000
Material etc.	-800000	-800000	-800000	-800000	-800000
risk reduction (like insurance)	-200000	-200000	-200000	-200000	-200000
revenues	4000000	4000000	4000000	4000000	4000000
taxes	-156782	-156782	-156782	-156782	-156782
total cash	-6056782	1943218	1943218	1943218	1943218
discounted total cash	-6056782	1868814	1797259	1728444	1662264

Tax calculation

profit before depreciation	2100000	2100000	2100000	2100000	2100000
depreciation	-1600000	-1600000	-1600000	-1600000	-1600000
profit after depreciation	500000	500000	500000	500000	500000
taxes	-156782	-156782	-156782	-156782	-156782

Net present value	**1000000**

Table 1: Model case: NPV-calculation within the decision-making-process of a company (example)

4) NPV as the gear box between political decisions and business actions

At first we have to assume that business decisions are based on structured analysis and finance/marked/value oriented. We know that in smaller companies and private households decisions based on NPV happen rarely. Even we heard about decision making support by analysing the position of the stars. These effects we have to exclude and we concentrate on companies with well-defined project management manuals and investment guidelines. All of them have in common the usage of NPV as the most important tool in the evaluation of new projects.

Economical movement in a country can only happen if a lot of companies react on political decisions. We can assume that the companies feel free to follow or not to follow friendly requests to take the governments wishes to heart. Even companies with leaders from the same party than chancellor or prime minister will not "just do it". The supervisory board consists on owners and employees and they need hard facts (so NPV-results) to agree to new investments and projects. So NPV is the key. If the NPV is higher the probability of making a decision in favour of the project is higher and multiplied with hundreds of companies a political effect will be visible.

In the following clauses we analyse ceteris paribus the impact of the six tools listed in chapter 2 on the NPV introduced in chapter 3 (and shaped in the model case). Because we use ceteris paribus assumption we will not repeat in every table the above mentioned basic information and just show where the lever is set and the result of the lever can be observed.

4.1 Grants and Subsidies in NPV model case

The easiest way to support new projects is also the easiest way to show the impact in a business case. The team calculating the NPV has just to add an additional positive cash line with the subsidies like for example 100000 in t=0 and 100000 in t=1.

General data	
discounting rate before tax	0,058
tax rate	0,314
discounting rate after tax	0,040

Capital data		
	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,04

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9617	0,9249	0,8895	0,8554
Investment	-8000000				
labor costs	-900000	-900000	-900000	-900000	-900000
Material etc.	-800000	-800000	-800000	-800000	-800000
risk reduction (like insurance)	-200000	-200000	-200000	-200000	-200000
revenues	4000000	4000000	4000000	4000000	4000000
Lever➔ subsidies	100000	100000			
taxes	-156782	-156782	-156782	-156782	-156782
total cash	-5956782	2043218	1943218	1943218	1943218
discounted total cash	-5956782	1964985	1797259	1728444	1662264

Tax calculation

profit before depreciation	2100000	2100000	2100000	2100000	2100000
depreciation	-1600000	-1600000	-1600000	-1600000	-1600000
profit after depreciation	500000	500000	500000	500000	500000
taxes	-156782	-156782	-156782	-156782	-156782

Result➔	Net present value	1196171

Table 2: Model case: NPV-calculation with subsidies in two years

The result can be observed immediately: the lever is shown in the table (additional positive cash) and the NPV increases as a result (arrow points up)

4.2 Reduction of Taxes in NPV model case

The reduction of taxes is more difficult than subsidies because taxes have two effects in a NPV-calculation with opposing directions. Taxes have to be paid so they have a negative effect on the volume of available cash. But on the other hand taxes have also negative effects on alternative investments so on the discounting rate "representing" opportunities. The discounting rate is lower and the NPV consequently higher. The author observed hundreds of NPV-calculations and never found one case, where the negative volume effect had a lower impact than the positive effect on the discounting rate. Although in literature there are some constructed cases (high depreciation effect, NPV close to "0", low costs) where a "tax paradox" can be shown [19, p. 21 ff]. This is not realistic and we can see also in the model case, that the reduction of taxes for example by 20% (the lever) has positive impact on NPV.

General data	
discounting rate before tax	0,058
Lever➔ tax rate	0,251
discounting rate after tax	0,043

Capital data	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,04

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9584	0,9185	0,8802	0,8436
Investment	-8000000				
labor costs	-900000	-900000	-900000	-900000	-900000
Material etc.	-800000	-800000	-800000	-800000	-800000
risk reduction (like insurance)	-200000	-200000	-200000	-200000	-200000
revenues	4000000	4000000	4000000	4000000	4000000
taxes	-125426	-125426	-125426	-125426	-125426
total cash	-6025426	1974574	1974574	1974574	1974574
discounted total cash	-6025426	1892350	1813551	1738032	1665658

Tax calculation

profit before depreciation	2100000	2100000	2100000	2100000	2100000
depreciation	-1600000	-1600000	-1600000	-1600000	-1600000
profit after depreciation	500000	500000	500000	500000	500000
taxes	-125426	-125426	-125426	-125426	-125426

Result➔	
Net present value	**1084165**

Table 3: Model case: NPV-calculation with 20% tax reduction

4.3 Pledges and Guarantees in NPV model case

The secret of a good business case is to create it in a way that the data are not just figures but they become true in the future and the NPV really can be achieved. There are many ways to secure the NPV calculation like key-turn-purchase, hedging, connecting salaries of project team with the figures etc. (23, p. 6 ff). If the state takes over risks of the project/deal (like the above mentioned Hermes Guarantees) these guarantees must not be purchased. So the figures of revenues from Russia or China (in case of Hermes) will remain on the same level but the costs on insurance will be reduced dramatically. We can again observe the lever in the next model-case-table and consequently the higher NPV as well.

General data					
discounting rate before tax	0,058				
tax rate	0,314				
discounting rate after tax	0,040				

Capital data		
	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,04

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9617	0,9249	0,8895	0,8554
Investment	-8000000				
labor costs	-900000	-900000	-900000	-900000	-900000
Material etc.	-800000	-800000	-800000	-800000	-800000
Lever➔ risk reduction (insurance)	-160000	-160000	-160000	-160000	-160000
revenues	4000000	4000000	4000000	4000000	4000000
taxes	-169325	-169325	-169325	-169325	-169325
total cash	-6029325	1970675	1970675	1970675	1970675
discounted total cash	-6029325	1895220	1822654	1752867	1685752

Tax calculation

profit before depreciation	2140000	2140000	2140000	2140000	2140000
depreciation	-1600000	-1600000	-1600000	-1600000	-1600000
profit after depreciation	540000	540000	540000	540000	540000
taxes	-169325	-169325	-169325	-169325	-169325

Result➔		
	Net present value	**1127169**

Table 4: Model case: NPV-calculation with 20% reduction on insurance costs

4.4 In Price reduced Loans in NPV model case

The discounting rate can be interpreted in different ways. As mentioned already as the interests on opportunities, as the average of capital costs (see model case) or as the hurdle rate for every investment/project a company intends to perform. If the state offers loans on a lower level than the market rate, the discounting rate as an average with own capital will decrease. This leads for projects to a higher NPV as it can be observed in the next adjustment in the model case.

General data	
discounting rate before tax	0,0524
tax rate	0,314
discounting rate after tax	0,036

Lever➔

Capital data		
	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,032

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9653	0,9318	0,8994	0,8682
Investment	-8000000				
labor costs	-900000	-900000	-900000	-900000	-900000
Material etc.	-800000	-800000	-800000	-800000	-800000
risk reduction (like insurance)	-200000	-200000	-200000	-200000	-200000
revenues	4000000	4000000	4000000	4000000	4000000
taxes	-156782	-156782	-156782	-156782	-156782
total cash	-6056782	1943218	1943218	1943218	1943218
discounted total cash	-6056782	1875749	1810622	1747756	1687074

Tax calculation

profit before depreciation	2100000	2100000	2100000	2100000	2100000
depreciation	-1600000	-1600000	-1600000	-1600000	-1600000
profit after depreciation	500000	500000	500000	500000	500000
taxes	-156782	-156782	-156782	-156782	-156782

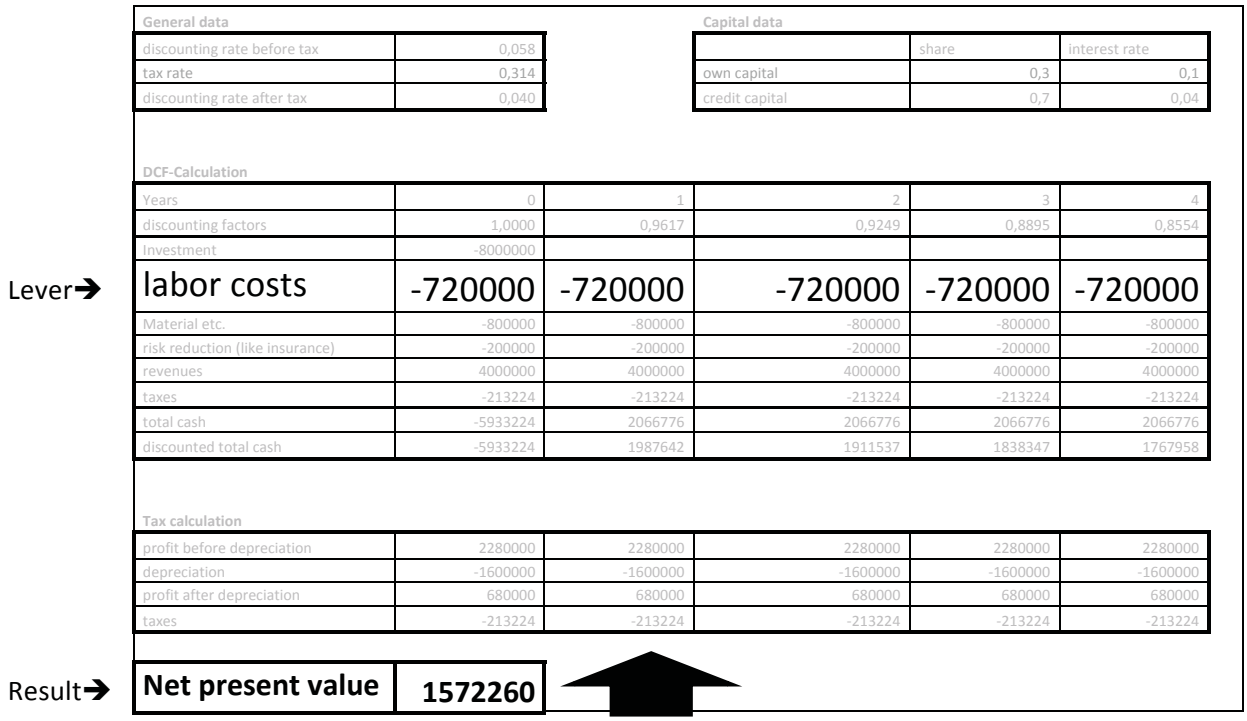
Result➔

Net present value	1064418

Table 5: Model case: NPV-calculation with 20% reduction on costs of credit capital

4.5 In Price reduced Labour Costs in NPV model case

This intervention can be foreseen easily because it directly reduces labour costs and the NPV will ceteris paribus be better. The state uses this instrument to fight against unemployment in general and to support economically weak regions. Table 6 shows the lever (for example 20 % labour cost reduction):



General data	
discounting rate before tax	0,058
tax rate	0,314
discounting rate after tax	0,040

Capital data		
	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,04

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9617	0,9249	0,8895	0,8554
Investment	-8000000				
Lever➔ labor costs	-720000	-720000	-720000	-720000	-720000
Material etc.	-800000	-800000	-800000	-800000	-800000
risk reduction (like insurance)	-200000	-200000	-200000	-200000	-200000
revenues	4000000	4000000	4000000	4000000	4000000
taxes	-213224	-213224	-213224	-213224	-213224
total cash	-5933224	2066776	2066776	2066776	2066776
discounted total cash	-5933224	1987642	1911537	1838347	1767958

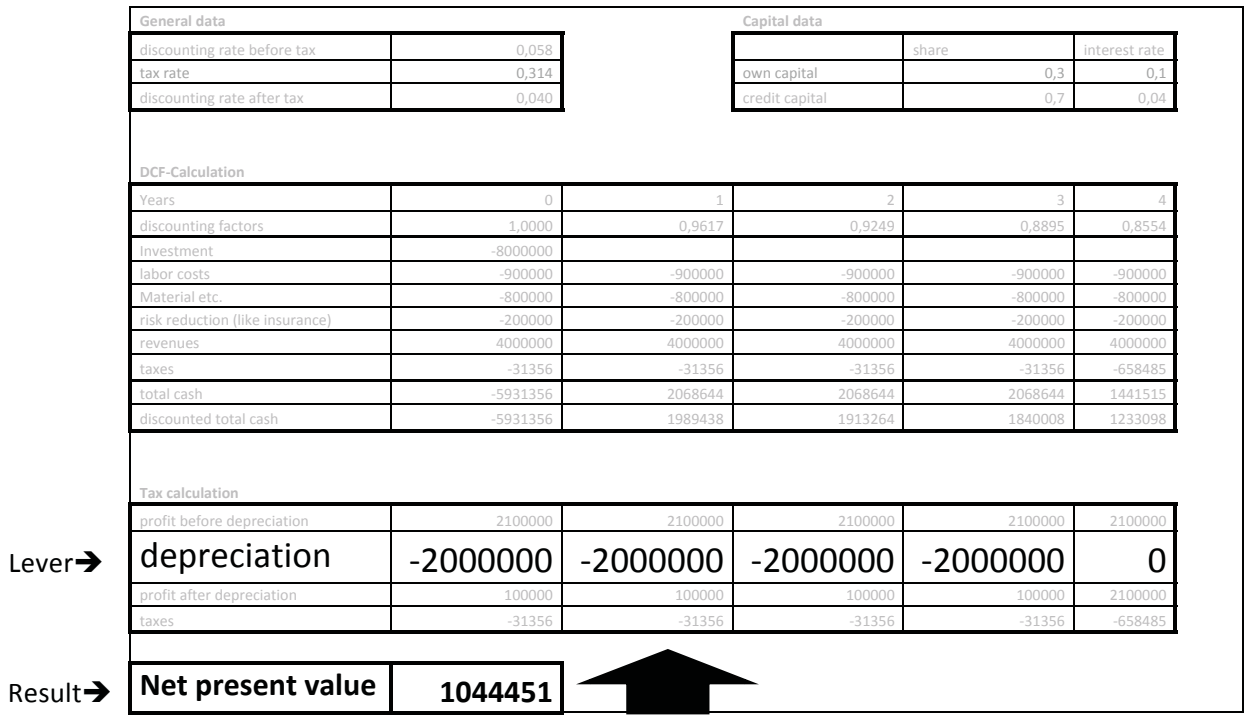
Tax calculation

profit before depreciation	2280000	2280000	2280000	2280000	2280000
depreciation	-1600000	-1600000	-1600000	-1600000	-1600000
profit after depreciation	680000	680000	680000	680000	680000
taxes	-213224	-213224	-213224	-213224	-213224

Result➔ Net present value	1572260

Table 6: Model case: NPV-calculation with 20% reduction on labour costs

4.6 Speeding up of Depreciation in NPV model case



General data	
discounting rate before tax	0,058
tax rate	0,314
discounting rate after tax	0,040

Capital data		
	share	interest rate
own capital	0,3	0,1
credit capital	0,7	0,04

DCF-Calculation

Years	0	1	2	3	4
discounting factors	1,0000	0,9617	0,9249	0,8895	0,8554
Investment	-8000000				
labor costs	-900000	-900000	-900000	-900000	-900000
Material etc.	-800000	-800000	-800000	-800000	-800000
risk reduction (like insurance)	-200000	-200000	-200000	-200000	-200000
revenues	4000000	4000000	4000000	4000000	4000000
taxes	-31356	-31356	-31356	-31356	-658485
total cash	-5931356	2068644	2068644	2068644	1441515
discounted total cash	-5931356	1989438	1913264	1840008	1233098

Tax calculation

profit before depreciation	2100000	2100000	2100000	2100000	2100000
Lever➔ depreciation	-2000000	-2000000	-2000000	-2000000	0
profit after depreciation	100000	100000	100000	100000	2100000
taxes	-31356	-31356	-31356	-31356	-658485

Result➔ Net present value	1044451

Table 7: Model case: NPV-calculation with 20% accelerated depreciation

In case of accelerated depreciation there is no effect of real cash reduction (compare the total amount of "total cash" in this case with the basic model case: it is the same with 1.716 Mio.). But the tax burden can be reduced in the first years and this safes interest in an amount of around 44000 if the depreciation is increased year by year by 20 %. In the last year you observe the amount of depreciation of "0" – the tax regulations will not allow to depreciate more than the investment volume.

5) Summary

The approach of this article was to show how in reality decisions in companies can be influenced by political authorities. All levers are shown in the next graph.

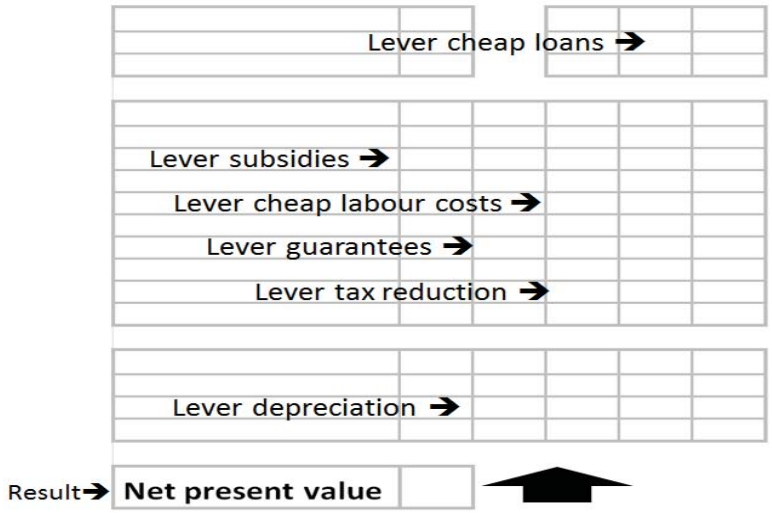


Table 8: Gear Box between Political Economy and Business Administration

It was not the target to find en empiric basement for the hypothesis that NPV-calculation at the end is the lever and gear box to let companies act accordingly. It was just shown in an example that the gear box works and different tools of the political authorities use different starting points for their lever – but all outcomes of political tools are covered in the NPV-calculation and should lead (and lead) to the same result: a higher NPV and a higher probability that companies decide according to political intervention.

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UNVEILEING INNOVATION BEYOND ECODESIGN: BASQUE EXPERIENCE AS A CASE STUDY

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Keywords: Eco-design, design for environment, design for sustainability, eco-innovation, innovation

Abstract: This paper explores the interplay between innovation, product design and sustainability criteria as well as the evolution of these interactions from eco-design concept focused on improving product environmental performance into eco-innovation as a systematic approach. Analytical frameworks are used to dissect a set of case studies from Basque small and medium enterprises (SME). The findings suggest that the implementation of eco-design methodology sprawls not only environmental but also technological, organizational and social innovations

1. Introduction

Ecodesign methodology plays a central role in the value creation cycle not only by releasing the pressures to deliver environmentally improved products, services and processes but also the pressures to learn about new approaches and knowledge through organizational and social arrangements that boost internal capabilities and stakeholders engagement. Tightly wired up to eco-innovation and ultimately to innovation, this paper explores the co-evolution of environmentally motivated innovations into technical, organizational and social innovations. The cross-sector eco-design experience in small and medium Basque enterprises (product and services industries) is examined using two overlapping analytical frameworks. First the wider and broad context where innovation, eco-innovation and eco-design activities occur and bequeath evidence is set. The following section describes the methodology used to analyze the rich and real world data gathered from selected cases compiled by the Basque governmental environmental agency. Afterwards, findings are consolidated to construct and ground emerging theories summarized in the closing results and conclusion section.

2. Setting the context

Innovation enfolds a concept with multiple faces and evolutionary perspectives. Thereof, it has been the primary focus of extensive research and experimentation in various scientific fields. Furthermore, any attempt to lock-in innovation drivers, factors, dynamics and repercussions into a single framework ignites a following wave of eager debate claiming to overcome biased approach and methodology dichotomies [1] [2] or a new arena of studies [3][4][5][6]. It unfolds two notions: a system of processes and its outcomes. Edquist and Hommen (1999) stated that the systems of innovation (SI*) "..explicitly recognizes the potentially complex interdependencies and possibilities for multiple kinds of interactions between the various elements"*. Innovation processes and outcomes occur in a wider context whose impacts are co-produced at the macro and micro-level [8]. At national or even regional level as driver of business success and at micro level as a business competitive advantage [9]. Noteboom (2008) stands for "*a complementary perspective of 'innovation systems', that takes into account interactions between a variety of agents, various dimensions of innovation, going far beyond science and technology, and a variety of economic and institutional conditions"*. Innovations outcomes are ideas, practices or objects perceived as new by the unit of adoption [10]. Moreover, once developed or adopted may inspire other outcomes further on or end up in new uses and users [8]. These spillovers in knowledge offer *"a non-linear perspective that … accords great importance to the demand side rather than concentrating primarily, if not exclusively, on the supply side",* scientific research funding will not automatically trigger technological development to fulfill market needs [7].

It is not until the industry had become familiar with the concepts of environmental management and cleaner processes that looked at the design of the product and eco-design principles to prevent environmental problems at source [11]. Considering the estimation that design process itself consumes few resources, representing about 15% of manufacturing costs yet it is responsible for the remaining 85%,

the industry embraced the eco-efficiency and life cycle thinking approaches and set initial targets: minimise the costs and adverse environmental impacts throughout the entire product life stages [12]. In 2011, The International Organization for Standardization (ISO) released the Environmental management systems – Guidelines for incorporating eco-design, ISO 14006 to seize the "*weak or completely missing linkage between Environmental Management Systems (EMS) and product development*" [12]. The standard interrelates ISO 9001 (Quality management systems), ISO 14000 standards (EMS), ISO Technical Report /TR 14062 and IEC 62430 (IEC-International Electro technical Commission) functional knowledge areas. Furthermore, the Spanish eco-design standard UNE 150301 and Spanish public institutions and private business eco-design experiences "*paved the way"* for the approval of the international standard [14]. From ISO 14006, eco-design *"can be understood as a process integrated within the design and development that aims to reduce environmental impacts and continually to improve the environmental performance of the products, throughout their life cycle from raw material extraction to end of life"*. Meanwhile academic and practitioners foresee far reaching objectives. Charter and Tischner (2001) defined ecodesign as *''Sustainable solutions are products, services, hybrids or system changes that minimize negative and maximize positive sustainability impacts e economic, environmental, social and ethical e throughout and beyond the life-cycle of existing products or solutions, while fulfilling acceptable societal"*.

3. Method and data

Case studies are rich, empirical evidence, such as historical accounts and descriptions of contemporary events, of particular instances of a phenomenon, typically based on a variety of data sources. Theory-building from case studies is the ideal approach to bridge rich qualitative data and deductive research. Multiple cases are discrete experiments that serve as replications, contrasts, and extensions to the emerging theory and therefore enable broader exploration of research questions and theoretical elaboration. Thus, multiple cases ground more robust, accurate and testable theory [16].

The unit of analysis is the ecodesign phenomenon. The central research question is how eco-design as a guidance and method contributes directly to eco-innovative and ultimately to innovative solutions? The main source of information is the 2011 Bilbao eco-design meeting memoire. This report compiled the Basque SME experience between 2001 and 2011 in ecodesign after local government initiatives via Ihobe to promote and support environmental practices and emerging eco-design concepts. By 2011, 138 firms were involved in at least one initiative, running a project (76/55%), being UNE150301 certified (62/45%) or issuing an eco-label/environmental product declaration (13/10%) or more. The Basques represent more than 50% of all UNE15031 certified companies. From these 138, 44 projects were selected as best practices cases. In turn, these practical cases have been triangulated with other information sources such as internal company reports and interviews, final year student's theses and other open access Ihobe reports [17].

The selection of the product for the project was based on relevant criteria, including, mature products, comply with customer needs and market requirements and renewal product or line of product design in progress. In the case of Ihobe and web portal (wwww.productsostenible.net) the unit of product is the Basque industry. Two analytical frameworks were integrated in order to dissect the multifaceted and entwined correlations amid eco-design, eco-innovation and innovation. On a broader level, the classification of innovations following the Oslo Manual guidelines (2005) was used to analyze their co-evolution. On the one hand, Rennings (2000) stated "the distinctions between the different kinds of innovations cannot be very sharp, different kinds of innovation go hand-in-hand or, using the terminology of Norgaard, they co-evolve. Organizational and social innovations would always have to accompany any technical innovations and some would have to come first". On the other hand, "the environmental gains from normal innovations have never been the object of systematic study" [8].

Within the wider context, the individual dimensions shape the eco-innovation. The eco-innovation dashboard framework proposed by Carrillo-Hermosilla et al (2009), characterizes the impact of the changes in the system by assessing and rating eight different dimensions in four categories: Design, user, product-service and governance. A one to five scale scores respectively incremental to radical changes. Despite this framework focus on the distinction between radical and gradual and continuous modifications, in this study was rather used as an analytical tool to identify the relationships that are replicated across most or all of the cases and mainstream theory building [16].

The design category assessed three dimensions; component addition, subsystem and system change. The characteristics of the component addition dimension are described as the development of additional components to reduce negative impacts on the environment, namely end-of-pipe technologies [19]. Thus, this dimension is applicable to process rather than products therefore out of the scope of the study.

Replications of similar dimensions across different cases grounded correlation between the dimensions and types of innovations. Once dissect the eco-innovation, the set of solutions chosen to seize the significant environmental impacts were contrasted with the classification of innovations. Motivated environmental innovation extensions to non-environmental innovations evidenced co-evolutionary innovation activities occurrences. Technological, organizational and social innovations either precede or follow environmental innovations.

4. Results and Conclusion

Ecodesign methodology bridges environmental and innovation areas of knowledge by assessing and incorporating critical dimensions in the product development process at early stages. Therefore, the impact of the eco-design changes in each study case were looked not only through environmental but innovation glasses.

4.1 Product Innovations

The assessment of the design dimensions opens up an opportunity to appraise and incorporate environmental factors up-front in the product development/renewal stage. Beyond its contribution to overall significant environmental impacts reduction, these dimensions model the product environmental performance. The system and sub-system dimensions parallel the two levels of improved environmental performances. Eco-effectiveness and ecoefficiency, respectively are defined by Jakobsen (2001) as follows: a) e*co-effectiveness is improving the total impact on environment when the consumers need or demand is satisfied by alternative fulfilment of the function in question and b)eco-efficiency is the improved environmental performance of a product through the selection of low-impact material, reduction of material usage, reduced energy consumption, reduced waste and pollution per functional unit of a product during its life cycle.*

The three eco-effective solutions observed where categorized as open systems or designs of products which are capable of being decomposed to become nutrients to new cycles within the ecosystem. The eco-efficient performance encompassed a range of solutions classified as less use of materials and/or resources, energy savings and pollution remission. Energy reduction could result from cumulative savings during product use or discrete cutbacks in shorter process cycles (manufacturing, assembly, stacking and/or disassembly). The improved environmental performance significantly contributes to value creation by enhancing product physical, economic and emotional functionality [13]. Over 70% of the less material and/or resources usage design changes implied product or component weight, size and volume reduction (individually or combined effect). In addition, energy losses reduction and energy efficiency and optimization enhanced the function of the ecoproducts. These physical functionality improvements had positive repercussions in the economic functionality through lower transportation costs, less packaging and easier disassembly.

4.2 Process innovations

The modern market perspective enlarges the concept of product to product-service system (PSS) approach [19] which refers to "*a system of products, services, supporting networks and infrastructure*". The product-service dimensions; change in product- service deliverable and change in value networks and processes, stress out the importance of expanding local optimization to whole supply chain, incorporate added-value thinking, and stretch value chains out to value networks. Process innovations are locked in the operational activities along the value chain and thus unexpected and underestimated. The adoption of environmental impact assessment software revealed the lack of eco-indicators for some raw materials and customization opportunities. As a consequence, the process innovation extended to technological innovations which followed ecosoftware up-grades to either calculate new ecoindicators or incorporate ecodesign alternative cost analysis tools. Linked to emotional functionality, process innovations included: a) easier and less frequent maintenance and repair b) progress awareness through activity consumption real data boards and feedback through monitoring laboratory and process indicators, c) increased recyclability by replacing non recyclable components, or increasing the use of recyclable components or building up or expanding reverse logistics, d) creation of a new environmental business unit and d) new closer supplier.

4.3 Marketing Innovations

The two user dimensions, development and acceptance, seek to benefit from the user's creativeness and inventive into the change process, not only by adopting innovations but also identifying breakthrough products or the opening of new markets. The introduction of eco-labelled products or identification, removal of toxicity pictograms of uncovered market segments (i.e, vulnerable or environmentally sensitive populations) boosts competitiveness and the development of new markets [13] and strengthen

the company's brand name [13]. In 27% of the cases, electric-electronic sector, imminent Energy-related (ErP) directives application motivated the implementation of ecodesign projects. Green public sector procurement initiatives hastened architecture (6) and furniture and equipment sectors pace (both sectors 35%). Fiercely international market competition and mature products encouraged the machinery-tool industry (11%) to step in ecodesign. Reaching new markets through ecobranding (local and European eco-labels) pulled the chemical sectors into environmental product design (11%).

4.4 Organizational and Social innovations

The governance dimension fosters organizations and institutions to develop mechanisms and instruments that stimulate eco-innovations such as decisive directives and strategies that strive for education and training programs, public-private partnerships, regulations and standards and public procurement, among others. Flows of knowledge were not limited to awareness, competences and training as ecothinking building blocks inside the organization [13] or across the value chain but further on the value network. Consolidating all projects, the actor network system comprised research centres, private and non-profit technological centres, universities, private consultancy firms, external designers, national and European industry associations, national and local professional associations, business development agencies, non-profit companies and eco-design centres network [17]

In the Basque eco-design experience, management by projects, flexible organizational forms and leadership unleashed ecothinking capabilities. Johansson and Magnusson (2006) [12] described the platform for ecodesign projects as the structure where the environmental issues are organized and prioritized as sub-projects. Knight and Jenkins (2009) observed that the cross-functional teams or "*a diverse range of staff were included, within the limits of ensuring competence, so that views from all levels of the organization could be ascertained"*. On top of other organizations embodied ecodesign approach to the mission as well as holistic and long term sustainability vision, and aligned ecodesign planning to business competitiveness strategies

In summary, eco-design outputs extend across environmental gains. Current eco-design debate is focused on its promising contribution to long-term radical innovations. Yet, there are underdeveloped capabilities in short-term continuous improvement experiences. Downstream at the level of the organization *"ecodesign tools should be compatible with the culture and current systems at a company level"* [12]. Basic business building blocks need to be thoughtfully and through fully re-evaluate under mandatory environmental considerations. Upstream, disengaging customer and user' desires and emotional values. Rich and real world data is attainable for further systematic study.

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EFFICIENCY PROBLEMS IN PUBLIC SECTOR PROJECTS PLANNING AND IMPLEMENTATION STAGE

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Abstract

Project management is at once one of the most important and most poorly understood areas of management. Delays and cost overruns are the rule rather than the exception in construction, defense, power generation, aerospace, product development, software, and other areas. Project management suffers from numerous problems of costing and scheduling. Cost overruns are common. Projects are often delayed to the point where the market conditions for which they were designed have changed. Project management is often counterintuitive.

Paper examinates public project management applications in the context of the underlying structure that create adverse dynamics and their application to specific areas of project management, synthesizes the policy messages, and provides directions for future research and writing. Public sector project management in Latvia become popular in recent years as there is different type of public funding sources available. The paper describes the public sector project management practice in Latvia. Study shows the evaluation of impact factors in public sector projects of efficiency and sustainability. Research period covers the time period from May 2013 – May 2014.

1. Introduction and Literature review

Government and organizations usually embark on different projects with the aim of creating new service or improving efficiency of the existing ones. All these projects require appropriate skills and techniques that go beyond technical expertise only, but encompass good and sound skills to manage limited budgets, while at the same time dealing with people and organizational issues. The motivation for research and this article is based on public investment rise in European Union, especially different kind of financial instruments available for new EU member states. Also in recent years has increased level of non-eligible costs in frame of public project expenditures. That made author to analyse problems of public investment project planning process in Latvia. The hypothesis of research problem is defined as: the public sector project are often based on political decision not on project management decision making tools; Experts involved in public sector PM defines themselves as well skilled but meanwhile don't use or use some of PM tools and technics; human resource plays crucial role in the public project planning and implementation process.

The **object** of the research is public sector project management.

The **aim** of the article is to evaluate project planning and initialization practice in public sector in Latvia as well as project management process efficiency using system dynamic approach.

The **objectives** of the article are as follows:

- assess the public sector project initialization practice and identify the problem areas of public project management in Latvia;
- analyse theoretical background of project management;
- provide problem identification model based on system dynamic approach;
- provide proposals for public sector project management improvement.

The research **methods** used in the article include the project empirical data analysis and literature review as well as survey based on questionnaire. Case study results are analysed with system dynamics methods and models has been elaborated for problem analysis. Study shows that public sector projects has lack of deep and well prepared initialization and planning stage.

Investment projects normally are large, non-recurring expenditures which involve multi-year funding, have a useful life greater than five years, are based on a comprehensive needs assessment, meet an essential public purpose, and require public accountability for funds. The recurring costs of investment projects on completion will have to be clearly understood and estimated by Public Bodies before embarking on the decision to go ahead with the projects. Investment projects may be funded from Government-owned resources, grants or loans from foreign institutions and/or by the private sector.

Problem analysis identifies the existing situation and establishes the *'cause and effect' relationships* between the problems that exist. It involves three steps:

1. Precise definition of the framework and subject of analysis.
2. Identification of the major problems and dangers faced by target groups.
3. Visualisation of the situation.

Project problems are ordinarily complex, consisting of many aspects that require analysis and insight [1]. We need to invest an appropriate amount of time to fully understand all aspects of the problem. Very often, what appears to be the problem is actually masking a bigger, more fundamental problem. Uncovering that fundamental problem is referred to as *identifying the true need*.

Governments in some jurisdictions provide guidance on how to appraise proposals, using cost-benefit analysis, before committing significant funds. For example, the governments of Australia, New Zealand, the United Kingdom, and the United States provide guidance on the issues and techniques that should be considered when assessing new regulatory, revenue or capital policies, programs, and projects. Such guidance advises public sector departments and authorities on how to undertake conventional analysis however; such guidance can offer advice on a broader economic cost-benefit analysis that can be more valuable to the public interest.

1.2. Public Sector Projects

Low institutional capacity

The World Bank [2] defines institutional capacity as the ability of an institution to decide and to pursue its goals, to perform tasks, and to improve performance constantly. In a public sector, institutional capacity can be defined as the organisation's ability to identify problems, to develop and evaluate policy alternatives, and to operate the government's programs [3]. It is commonly believed that public sector organisations in less developed countries still have a limited institutional capacity [4]. Some of the characteristics of public sector organisation with weak institutional capacity are:

- weakness in regulatory practice,
- a low level of public accountability,
- administrative inefficiencies,
- limited human resources,
- a lack of facilities,
- and insufficient funding [5].

These characteristics lead to situations in which it takes long bureaucratic procedures, with a lack of transparency, to inadequate delivery of goods and services to the citizens [3].

Limited Involvement of Stakeholders

The involvement of stakeholders –such as citizens- in the public sector organisations is limited in the less developed countries as compared to the developed countries [6]. It seems that public sector organisations pay attention only to the more powerful stakeholders. Batley [7] indicates that the officials and the civil servants of the public sector organisations are powerful group being the internal stakeholders. The external stakeholders, such as donor agencies and nongovernmental organisations (NGOs) have also been able to achieve influence usually because of the funding that they can provide to public sector organisations [3].

To reap the benefits of managing by projects DPWS recognises that the organisation must provide support for their projects and their people, to assist them in working together on projects to achieve corporate goals. This support should include systems for management of portfolios of projects, and training to develop the project management competence of all staff. In adopting a Management by Projects approach, the Department recognises that it is essential that the people within the organisation understand the approach, understand their roles and have the skills to work effectively within this environment [8].

Challenges for the Public Sector

Having grown progressively following the Second World War, the public sector, throughout the world, began, during the early 1970's, to experience significant pressures for change. A primary focus was 'reducing expenditures while at the same time improving government operations' [9].
According to the OECD [10], catalysts for change have included:

- need for increased efficiency and cost-effectiveness to control and reduce public spending
- reduction in national differences in public sectors and increasing desire to enhance competitiveness of national economies as a result of globalisation
- rising service quality expectations from individuals and business
- need to respond flexibly and strategically to external changes opportunities offered by new information Technologies

Since the early 1980's, common themes have emerged in the responses by national public sectors to the need for change:

- emphasis on strategic management and planning [11] efforts to increase service quality and become more responsive through debureaucratisation', allowing initiatives such as integrated service delivery [12,13]
- increased public consultation in design and execution of policy
- introduction of performance measurements associated with emphasis on and accountability for results
- attempts to replace the 'tradition of predictability and regularity that was the trademark of old public administration' with adaptability and flexibility [14]

1.3.Public investment – role and importance

Investments can be seen as a bridge between generations, both for creating jobs for the young generation, and for inheriting the fixed assets, which it receives from previous generations. Also, investments are the material support for introducing the technical progress in all sectors of activity, while systematic updating allows maintaining them within the superior performance parameters.

The concept of economic sustainable development means both resource protection in terms of raw materials, and environmental protection and restoration of ecological balance in order to provide equal opportunities to the future generations. Any investment project has an environmental component on which the investment decision will be built [15]. Public investments are defined as funds allocated by the authorities of the central or local public administration to achieve objectives or works of general interest in a certain administrative unit [16]. Public investments are designed to ensure the development of the society in general, seen as a whole. The effects of the public investments can be found in the social, cultural, health, science, publicē order, etc. fields.

Public investment funds are limited through budget restrictions, however consuming and exceeding the limits granted in the originally approved budget can be made only by obtaining additional allowances or by redistributing the funds within the budget.

Strategies, represented by the goals of the public projects, are a need for local authorities which have the possibility to implement investment projects based on the following: election programs, making a poll of the public opinion, establishing a long- or short-term thinking, establishing the way forward so that the relationship authority - community can run in the most harmonious manner possible. Public investment projects provide a direct correlation between the fundamental objectives, which take the form of capital expenditure, which in their turn, lead to producing public assets [17].

Public investment management processes and practices are affected by the broader governance of the public sector. In the UK and Ireland, for example, the public administration has adopted a more managerial culture, while many EU counties still rely extensively on laws and decrees for policy implementation. This can mean that the process of innovation and adaptation is likely to be much slower. Moreover, the reach of politicians into the detailed management processes of individual ministries can be extensive in some EU countries. Despite the high demand for public infrastructure investment, the capacity of the EU countries to use the funds effectively can be limited by various factors. Public investment planning in the EU countries tends to be shorter-term and often politicized. While all countries have prepared various medium- to long-term economic development strategies, they tend to be all-encompassing with strategic investment priorities not clearly defined. Project appraisal is weak, especially the link to the budget process. Accountability arrangements also tend to be weak both in terms of identifying the full cost of projects and in comparing anticipated and actual outcomes.

Strong planning and management systems are essential to ensuring productive infrastructure investments. The experience from earlier EU accession countries shows that it can make a difference how well countries plan for and use the available structural funds, and there is ample evidence also from other parts of the world that good public investment planning is key to ensuring productive infrastructure investments.

1.4.The Impact of Project Appraisal on Project Selection

The quality of project appraisal practices is difficult to assess accurately. However, in most of the EU countries the results of the appraisal process do not necessarily determine the decision about which projects will go forward and the system still allows a wide political discretion in the selection of individual projects.

Though cost-benefit analysis is a standard component of project appraisal in all countries, especially for EU funded projects, the quality of the analysis is typically not independently reviewed and the resulting analysis is not necessarily a significant factor in the project selection. While various projects could generate positive economic benefits, it is rare to assess their relative value-for-money. Moreover, project appraisal processes in the EU countries give much less attention to business case justification, project management arrangements, risk mitigation, and procurement strategies than is the case in the UK or Ireland.

Substantial progress has been made in the EU10 countries to establish a good framework for public investment. Yet, the urgency to catch up on infrastructure investments and to utilize more fully EU funds sometimes competes is seen as competing with the application of robust value-for-money analysis to projects. This note has argued that the use of such funds should be more strongly linked to good investment practice, beyond merely requiring that cost benefit analyses be undertaken. Although many projects may demonstrate positive cost-benefit ratios, the relative cost- effectiveness of project designs and policy options needs more attention. Since the sector strategies themselves are often broad unprioritized lists, many potential projects can be loosely linked in support of the strategy. This note's recommendations are:

• Strategies linked to budgets: Strategic plans have to be linked to published government policy and to a reliable resource envelope if they are to generate genuine prioritization among competing policy options. To the extent possible the strategic plans should be updated on a rolling basis and indicate how specific programs or projects contribute to the policy objectives established for the sector.

• Multi-year funding commitments: Spending authorizations for capital projects need to be made for a multi-year period covering the duration of the project or the project phase. At the same time, implementing agencies should also have flexibility to program the actual resources according to the specific needs of individual projects, e.g., by grouping projects within a "program" and authorizing moderate reallocations to occur between faster and slower moving projects.

• Cost-benefit assessment: The selection of individual projects within the overall strategic plan should be driven by high-quality analytical assessments of competing projects which in turn could more effectively inform political judgments. Projects need to be assessed against alternative options to assure appropriate value for money.

• Ex-post evaluation: The public investment management system should require evaluation of past project experiences and incorporate the lessons into future guidance and regulations. These reviews could be undertaken by any number of institutions, including ministries of finance.

• Investment in skills: Project planning and project management skills need to be enhanced and retained within the civil service. Such skills are needed for effective management both within the public sector and the private sector (the latter may be undertaking investment on behalf of the government) [18].

1.5.Effectiveness in the Public Sector and Nonmonetary Benefits

In the public sector there is a vast number and diverse range of potential uses of resources and the efficient use of resources has a significant impact on the welfare of citizens. As resources are finite, a decision to implement one proposal may preclude implementing others. There are always alternatives that need comparison even if the choice is between 'doing something' and 'doing nothing or the minimum'. In considering a spending proposal, decision makers need to be assured that the overall welfare of society is raised as a result of the proposed action. CBA attempts to evaluate the proposal from the perspective of society by placing all the costs and benefits on a comparative monetary scale [19]. If the project is expected to generate benefits that cannot be measured in monetary terms, the analysis (a) clearly defines and justifies the project objectives, reviewing broader sectorial or economy wide programs to ensure that

the objectives have been appropriately chosen, and (b) shows that the project represents the least-cost way of attaining the stated objectives [20].
The results of cost-effectiveness analysis need not be expressed in monetary form. It can be applied to public sector investment projects, where there is a large number of relevant quantitative project indicators that still cannot be expressed monetarily, while being comparable with the appropriate quantitative indications of other analogous projects.
According to Kazanovski [21], a cost-effectiveness analysis requires the fulfillment of three conditions:

- determining a common goal or application that must be achieved;
- the existence of alternatives to the achievement of the goal;
- the existence of limiting factors in the solution of the problem.

Goals are needed in order to have a base for comparison. For example, it would not make sense to compare investments in the production of submarines with investments in a highly developed communications network. In addition, alternative ways of goal fulfillment must exist in order to be able to compare them. Finally, the limiting factors of time, price or efficiency must be within reasonable bounds, so that the possibilities that are being considered can be determined and defined in the best possible way. Kazanovski points out that it is necessary to fulfill 10 standard steps in order for the approach to analysis to be correct, and that they must be fulfilled in a certain order:

1) Define the goals, purpose, application and everything else of significance for the project. Cost-effectiveness analysis will find the best possible way for their achievement.
2) List the conditions necessary for the achievement of goals. This means to first present the basic prerequisite for the achievement of the goal, followed by the others.
3) Develop alternatives for achieving the goals. At least two possible ways to achieve a goal must exist.
4) Determine verification measures that are acceptable for the proposed alternatives. A possible list of valuation criteria would be: feasibility, availability, reliability, sustainability, etc.
5) Choose an approach for determining fixed successes and fixed costs. In using fixed success criteria, the most favorable alternative is the one with the minimum price of achieving separate goals or degrees of success. The options that cannot achieve goals at that price are either excluded or penalized. In using fixed cost criteria, the amount of achieved results at a given price is taken, where the "price" is usually the present value of annual costs during the project life cycle, encompassing research and development, engineering, construction, project implementation, maintenance, protection and other costs incurred by the project during its life cycle.
6) Determine the advantages of an alternative expressed in established valuation measures.
7) Express alternatives and their advantages in an acceptable way. 8) Analyze different alternatives on the basis of success criteria and cost consideration.
8) Analyze the sensitivity of alternatives, in order to see how small changes in assumptions or conditions cause changes in alternatives.
9) Submit in writing all considerations, analyses and conclusions from the previous nine steps.

Throughout the last three decades, the focus on CBA as a vehicle for economic efficiency appraisal of public projects has increased. Several studies [22,23,24,25] have shown that a crucial role play a choice and valuation of benefits and costs in public projects evaluation. However more often there have indicated problems of proper discount rate choice [26,27,28].

Another strand of this literature finds that the broader institutional context within which investment decisions are undertaken and the quality of project selection, management, and implementation play a crucial role in determining the return on investment and its growth dividends [29,30].

Public investment, particularly infrastructure, may also respond to political economy motives rather than simple economic efficiency considerations. For example, Henisz and Zelner [31] present evidence that interest group pressure and the structure of political institutions affects investments by state-owned electric utilities. Guasch [32] et al. (2007) show that weak operational frameworks increase the likelihood of political interference and make the expropriation of sunk investments more likely, jeopardizing the realization of medium term returns. Many of these problems are more acute in low-income countries.

The importance of the quality and efficiency of public investment spending has also been highlighted in arguments for granting countries additional fiscal space for productive investment. A number of studies argue that the failure to recognize the asset-creating nature of investment and the inter-temporal tradeoffs involved creates an anti-investment bias in developing countries, with negative consequences for growth [33,34,35].

These studies note, however, that public investments are likely to exhibit higher marginal productivity *ex post* if the government is able to *ex ante* select high return projects—thereby significantly cutting down on wasteful projects and insuring efficient utilization of fiscal resources for investment spending.

1.6.Project Selection and Budgeting

The process of appraising and selecting public investment projects needs to be linked with the budget cycle. Cross-country experience suggests that in the absence of proper integration, governments resort to borrowing without due consideration of the sustainability aspects, assets are inadequately maintained, and major projects suffer from poor management and performance [36]. Our index assesses these dimensions using the following criteria:

- A medium-term framework that translates fiscal objectives or rules into a credible plan for the evolution of fiscal aggregates is important for evaluating the sustainability of the investment program. This is evaluated in two separate criteria: assessing the existence of multi-year forecasts and their linkage to annual budgetary policies; and the integration of recurrent and investment expenditures in the budget to determine whether multi-year current and new sector polices can be financed within annual aggregate fiscal targets.
- Efficient investment requires sound decisions in the choice of investments, active management of the asset portfolio (including through disposals), and a budgetary process that allocates recurrent funding to operate and maintain existing assets. The latter is especially important for donor funded projects that create assets, which can be significant in many low-income countries, while operation and maintenance costs are borne by government. To this end, our index assesses the inclusion of information on donor-funded investment projects in the budget.
- In some settings, formal project selection checks are avoided by “jumping the fence”, or side-stepping controls put in place to keep out poor quality projects. A more formal review process through the budget committee or equivalent of the legislature, backed up by high levels of public disclosure, could assist in reinforcing the appraisal standards and gateways put in place.

In order to comply with these standards, Member States are required to set up complex management and control systems, where particular attention has been given to the division and description of responsibilities, taking due account of the principle of separation of functions (Art. 58 of the general regulation), establishment of financial flows, together with the required documentation flow from the European Commission to the beneficiary and backwards in case of recoveries (audit trails) and crucially the control provisions, which need to be specified in detail (specification of responsibilities, control lists, risk analyses where sample checks are used, etc).

From the more public choice arena, he makes observations as to the relationship between political sphere and absorption, especially from the perspective of staff requirements and institutional structures. The author calls for timely reorganisation and the need to ensure continuity of personnel whatever the organisational changes. He also draws attention to the necessity of having close political relationship between the Managing Authority and the Prime Minister.

2. Research, Case of Latvia

2.1. Project Problem Definition and its Modelling

The essence of planning is the opportunity to see the threats and remove them or to use it in decision making process. Project planning defines the project management team's responsibility, the allocation of costs, the division of labor and the level of control [37].

Justification of a problem situation should make sure it describes a controversy, not just lists a number of various facts. A typical mistake is to indicate in the project submission the desired situation, not describing the existing. In such a case the problem justifying the need for the project is not demonstrated. Therefore, the problem results from the problem situation. If a problem situation is not analyzed in sufficient detail, the solution, too, can be incomplete. To justify the necessity for the project,

it is best to start by describing the issue in question or the problem topicality. Municipalities are forced in their work to solve problem situations involving various target groups.

Analysis of the initiation documentation of the selected projects reveals the main mistakes in the problem situation description:

1. Project topicality is not described – no justification of the significance, importance of the problem for the specific city, in the particular period of time.
2. Some fragments mention the region or state in general, others the municipality.
3. Terms are not understood.
4. Generally known statements are used, not sustained by facts.

Part of that problem has been the lack of a structured approach for decision-making, project approval, and project execution. All this can be satisfied with a sound project management methodology. To describe problem definition role and importance in project management author has elaborated system dynamic oriented model for problem definition. System dynamics is a methodology and mathematical modeling technique for framing, understanding, and discussing complex issues and problems. Originally developed in the 1950s to help corporate managers improve their understanding of industrial processes, system dynamics is currently being used throughout the public and private sector for policy analysis and design. Problem solving models attempt to capture important aspects of the problem solving process. As decision-making and problem solving are intimately related, it is not surprising then that the Simon model of the decision-making process is the foundation for a number of problem solving models [38,39,40].

Problem analysis methods are rarely used in development of municipality projects. When all the problems and target group needs mentioned in the problem situation are summarized, each problem should have planned actions to match it (several problems could be solved by one action, and one problem could have several actions planned for its solution). Conclusions describe the influence of the planned actions on the target group needs [41].

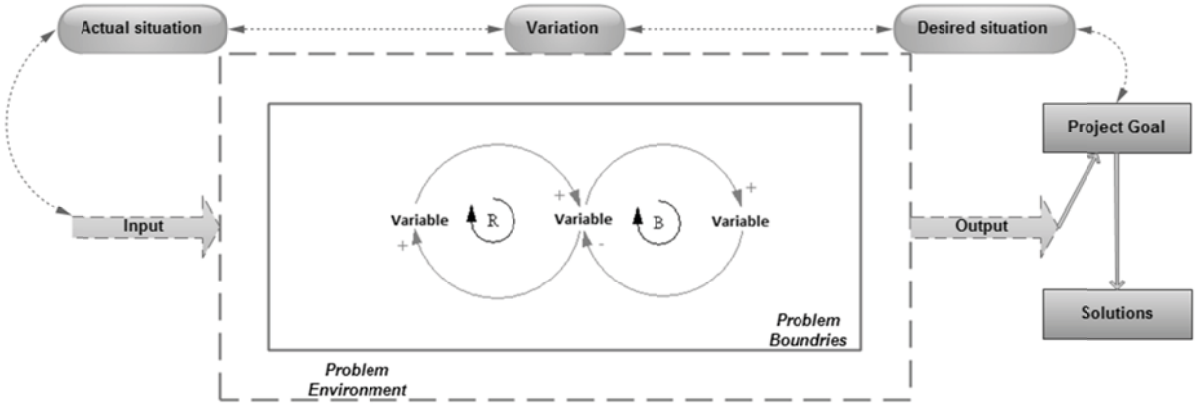

Figure 1. *Problem definition model*
Source: Author elaborated model based on qualitative analysis

Problem definition involves both textual and graphical statements of problematic behaviour. Conceptualization entails identifying feedback loops that are hypothesized to underlie observed patterns of system behaviour. Model formulation is the process of moving from a theory of underlying structure to a fully specified mathematical model so that the theory can be tested. In this assignment, the skills involved in problem definition and model conceptualization are treated separately. Later assignments will bring these skills together with those of formulation and analysis to focus on a variety of strategic and operational problems. The attributes chosen differentiates a scenario assignment from an action assignment. The constraints for value assignments prevent action assignments from overriding scenario assignments. In short, a scenario assigns values to attributes (variables) that the action component must treat as uncontrollable variables. These value assignments reflect an intuitive assessment of the assumptions that the problem model will work under. By identifying some attribute assignments as scenarios, problem solvers gain greater flexibility in testing the robustness of their problem solving actions under a range of different assumptions. Step 1. Start with a problem – characterize it in simple terms such that it would be clear to all who have even peripheral understanding of it. What is wrong?

What is the root source of the problem? Step 2. Begin defining the causes of the problem. We should start with a fact in the loop. State it in sentences such that there is a relationship between cause and effect. Step 3. Each cause becomes an effect of the next. To find a cause, we need to answer question Why? To find out the effect, we need to discover what happens. It's a probing process of Why's. Directional relation of the loops goes from Cause to Effect. Step 4. Show relation between Cause to Effect as reinforcing (+) or negative (-). This does not indicate good or bad it just means as the cause goes intensifies, effects does too (+) and as cause diminishes, effect does also (-). A negative or balancing loop (-) is referred to as a "goal seeking" loop. There is a mechanism in this loop that is trying to maintain some level of stability.

Another key group of variables includes the variances associated with four Project goals: schedule, cost, and quality. Variances occur when actual Project characteristics are less than the planned characteristics at a specific point in time. For example, schedule variance means the project is behind schedule, cost variance means the project is over budget, quality variance means that rework is necessary (Figure 2).

Another group of variables include the project manager's emphases on the four areas of project goals. The arrows between these variables reflect the assumption that while project managers may have specific goals in all four areas, it is the relative emphases between the goals that is important. In other words, a project manager cannot effectively emphasize all criteria; project personnel will focus on the area or areas that their supervisor emphasizes the most.

Overtime and Fatigue are another set of important variables due to their assumed effects on variances. If schedule variance occurs, project managers will typically attempt to get back on schedule by directing overtime, which leads to cost variance.

In every project decision process we should pay full atention to proceses inside the model to get the best results and found appropriate problem solution. Author provided model shows input, process and outputs for defining project problem. If there is adequate problem description we can set up appropriate goals and solutions to be achieved in the frame of project. Such a model can be used in project management practice and academic disclipines.

This initial representation indicates that at the Work Remaining with regard to the current project schedule increases it will tend to produce Schedule Pressure. This Schedule Pressure with tend to promote Overtime to reduce the Work Remaining with regard to the current project schedule. This structure represents a balancing loop where Overtime is used to counteract the Work Remaining.

While the Overtime is intended to counteract the Work Remaining it has a couple additional influences. If Overtime increases sufficiently it will begin to depress Morale, which will subsequently influence Productivity to decrease. The decrease in Productivity will then tend to increase the Overtime required. This structure represents a viscous reinforcing loop moving opposite to the direction desired.

At the same time an increases in Overtime influence an increase in Fatigue. The increase in Fatigue will then tend to reduce Productivity further increasing the Overtime required. What we have is another viscous reinforcing loop moving opposite to the direction desired.

An increase in Overtime brings with it an increase in Overtime Cost. As Overtime Cost increases there is an increased emphasis on cost which shows up as Cost Pressure. The Cost Pressure is interpreted by the management of project in such a way that it shows up as additional Schedule Pressure. This increased Schedule Pressure then leads to even more Overtime. Here we have but one more viscous reinforcing loop in which actions influence the overall effect to be just the opposite of what is desired.

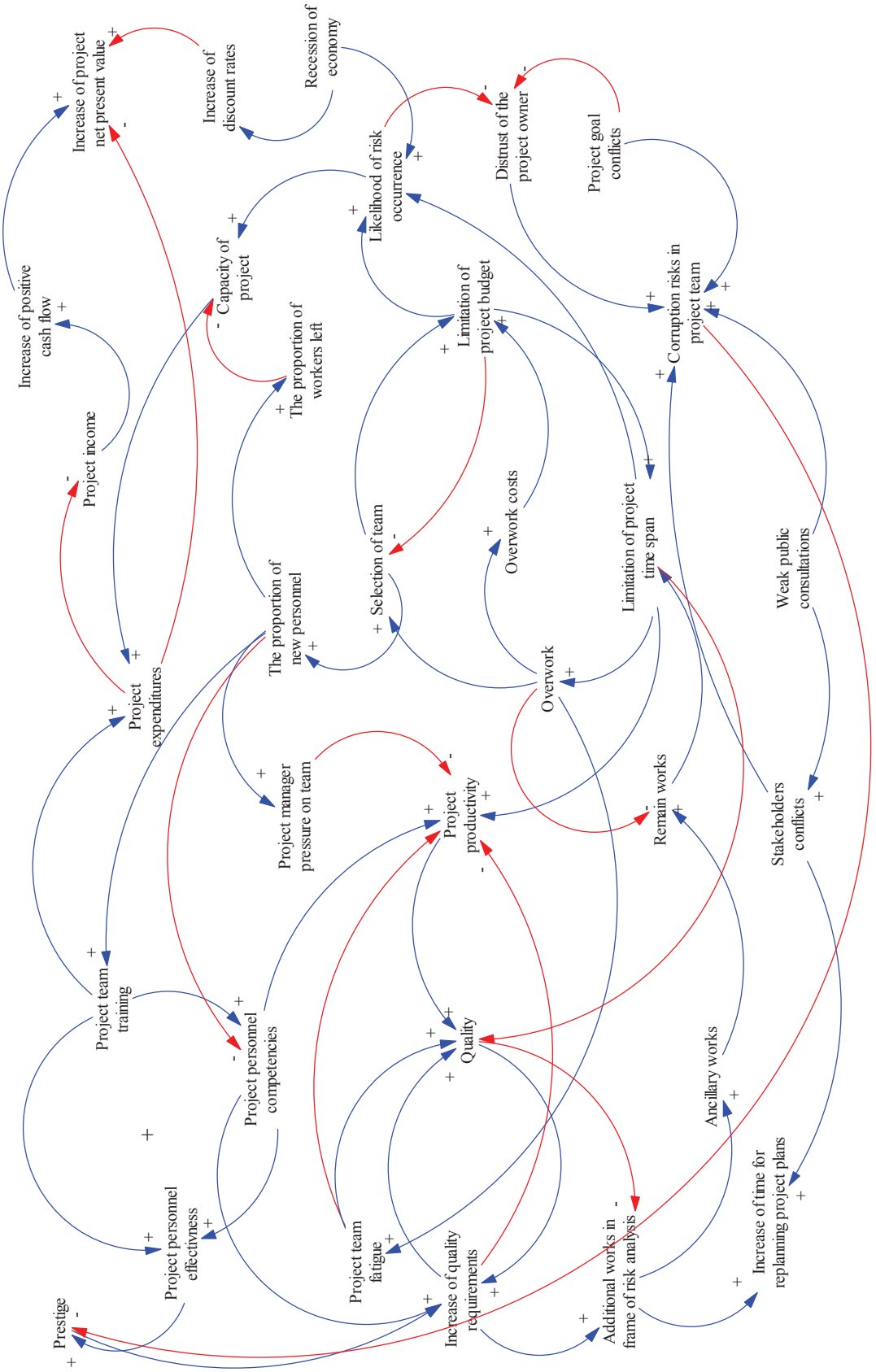

Figure 2. *Causal loop diagram*
Source: Author eloborated model, based on case study

While managers have little control over projects, they do have great influence in avoiding the unintended and counter intuitive consequences that that cause projects to falter. Systems thinking can help managers, engineers and programmers understand the dynamics of project system, their part in the system, and the varieties of policy feedback that cause project performance problems. Such a systems perspective sheds light on what doesn't work, and on what does work, in managing software projects. For example, demanding excessive overtime and hiring personnel too rapidly definitely don't work because they have an adverse impact on quality and productivity - and ultimately on project schedule and cost.

Among the things that work are to

- do excellent planning including product specs, project plans and test plans before starting development,
- guard band schedule beyond the minimum development time because,
- identify independent, parallel development opportunities because two decoupled sub-projects take about one quarter the manpower of one large project of the same size,
- test as soon as possible to avoid the effect of defects on downstream code, and
- before the project starts, identify optional functions that can be worked on later, or dropped, if the project gets in trouble.

Most system dynamics problems are non-linear. This means that the cause-effect relations between variables are not proportional. Non-linear effects are subtle, because a certain effect observed in one range may not be valid at all in another range. Non-linearity furthermore often means that there are "interaction effects" between variables. Non-linearity is very hard to analyze not only intuitively, but also mathematically, especially when embedded in a dynamic feedback context. As the number of variables increases, the complexity of the problem increases nonlinearly. With only three or four variables, even a non-linear feedback problem can be analyzed in most cases mathematically and perhaps intuitively. But even "small size" policy problems involve tens of variables. At this scale, a non-linear feedback problem immediately becomes impossibly hard to track – mathematically and intuitively.

As the minor problems respondents identified: frequent change of management official's decisions and initiatives, corruption, changes in responsible officials and political leaders. As the important or very important problem factors which could affect the ability and capacity of local government projects respondents defined: management official's lack of understanding of project management issues, inadequate staff motivation system, lack of human resources and lack of project management competencies and professional skills.

Authors has elaborated survey questionnaire for local municipality project management specialists.

Questionnaire has been sent to all Latvian municipalities (in total 119), in the frame of study 97 responses has been collected (research sample is 97 out of 119, n=97). Research period is January 2013 – February 2014.

Quantitative analysis carried out in two steps: describing the central tendency and variation of parameters and in accordance with the empirical distribution with the normal distribution choice of parametric or non-parametric method for Inferential Statistics.

Study shows (Figure 3) that in public sector project management there is lack of deep problem and situation analysis. 45.78% of respondents elaborated project proposals based on local municipal development programs and policy planning documents and don't provide deep analysis of problems. 26.05% of respondents accepted that they don't use situation analysis methods but project proposals are elaborated based on desired situation. Still 28.17% of respondents showed that they used project management methods such as current situation analysis and research, case study methods by clarifying the factual situation and the desired situation.

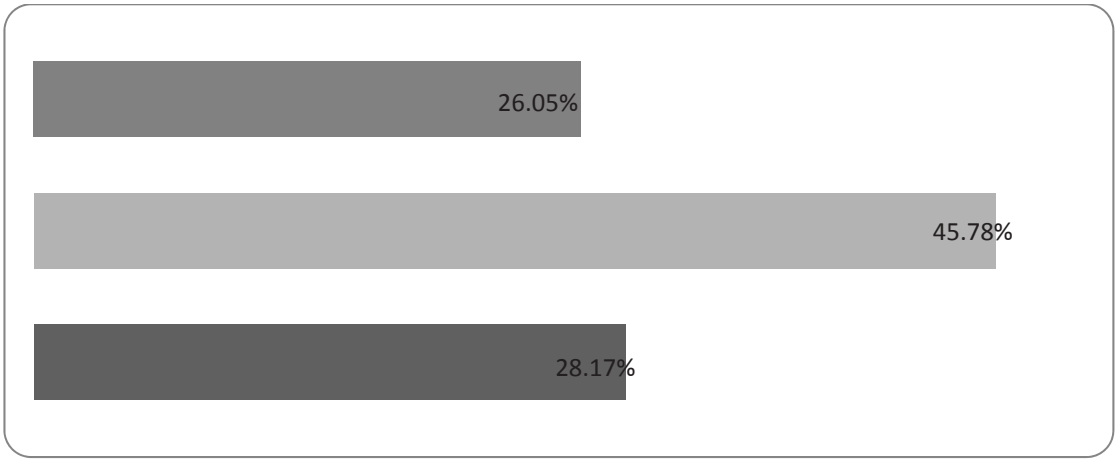

Figure 3. *Problem definition practice in public sector in Latvia* (n=119)
Source: author empirical research

Conclusions and Recommendations

In the public and not-for-profit sectors, delivering sustainable value involves ensuring that public funds are spent in the most effective and efficient way and consistent with long-term objectives, and that services provide the desired benefits to society. Organizations should place investment appraisal in a wider strategic context in terms of how an investment supports the achievement of strategic objectives, goals, and targets and responds to opportunity and/or risk. For example, determining whether acquisition or internal growth is most effective in reaching an organization's strategic objectives requires an understanding of the business environment and an organization's specific situation. A wider strategic analysis might include an assessment of (a) state and region economics, (b) economic profitability across markets, products, and customers, (c) determinants of sustainable demands and competitive position, and (d) alternative options.

All available measures for improvement must be employed. The conventional mode of planning and designing infrastructure has long historical roots and is deeply ingrained in professional and institutional practices. It would be naive to think it is easily toppled. Given the stakes involved saving taxpayers from billions of dollars of waste, protecting citizens' trust in democracy and the rule of law, avoiding the destruction of spatial and environmental assets - this shouldn't deter us from trying.

Public sector project realization planning represents a project management phase that encompasses goal definition and the determination of ways and measures for achieving the set goals, i.e., that the project is realized in the planned time, at the planned cost. Whether projects are public, private, or public-private, they should be vested in one and only one project organization with a strong governance framework. The project organization may be a company or not, public or private, or a mixture. What is important is that this organization enforces accountability vis-à-vis contractors, operators, etc., and that, in turn, the directors of the organization are held accountable for any cost overruns, benefits shortfall, faulty designs, unmitigated risks, etc. that may occur during project planning, implementation, and operations. If the institutions with responsibility for developing and building major public projects would effectively implement, embed, and enforce such measures of accountability, then the misrepresentation in cost, benefit, and risk estimates, which is widespread today, may be mitigated. If this is not done, misrepresentation is likely to continue, and the allocation of funds for infrastructure is likely to continue to be wasteful and undemocratic.

To improve project management practice and efficiency in public sector in Latvia, author can recommend:

- To increase the capacity and professional skills level for local municipal project management staff (training programs, supervisions etc.);
- Define the appropriate organizational structure for project elaboration and implementation;
- Project management tools and techniques should be applied gradually (should be as an obligatory requirement in big scale public sector projects).

In summary of the study results, the authors define the planning phase as the most important project management process, since adequate planning process is a factor for successful project introduction. It is the use of inappropriate project management planning methods in municipalities that

creates problems in the project implementation and introduction phase, the results of which follow from low-quality technical projects, procurement documents, incompletely developed risk analysis and cost-benefit analysis.

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Project management process in public projects in Latvia

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Keywords: Project Management Process, Public Projects

Abstract
Over the last fifty years project management has gained world-wide popularity both in business and state administration. While companies have no hesitation to use project management and its various methods and aim for their efficient application, the situation in state administration quite different. Many countries have realized the importance of project management methodology in efficiency, productivity, and resource optimization; others countries see project management as a new type of state administration and believe it can provide great benefit to state administration in general.
The purpose of the article is to study of the typical mistakes in the project management process financed by the European Union in Latvia in the planning period of 2007-2013, based on the audits and revisions of institutions involved in the EU fund management carried out over the current planinng period of 2007-2013.

1. Project management and project management process

Project management makes use of several international standards defining and describing a project, project management process, project targets and tasks. E.g. H. Kerzner notes that project management has grown into a corporate level project management system, which has effect on each of the functional units of the business. The IPMA competence baseline (2006) defines a project as an operation characterized by certain constraints, e.g. targets, time, finances and cost constrained operation to realize a set of defined deliverables (the scope to fulfill the project's objectives) up to quality standards and requirements. According to the Project Management Institute of USA, a project is a temporary endeavor undertaken to create a unique product, service, or result (PMI, 2008). In quality management, a project is defined as a unique process consisting of a set of co-ordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including constraints of time, cost and resources (ISO 10006). Project management is made up of many different interrelated operations or activities aiming to achieve a common goal. The main purpose of a project is fulfilled only when all activities have been realized. A project is characterized by its dynamic nature - ability to react to change and problems.
There are several definitions and explanations of project management process in the scientific literature on project management:
* The project management process is defined based on the process description and measurable results. It improves the project management quality (Gareis R., Stummer M., 2008)
* PMBOK Guide (PMI, 2008) states that project management consists of two processes: project management process and product-oriented process
* The project management process is a set of focused activities showing and organizing the project progress (Collins, RJ, 2011)
In light of these descriptions it can be determined that the project management process consists of several processes organizing the project progress.

The project life cycle consists of four phases (Westland, 2006). Figure 1 clearly shows project management processes applied against the various stages of the life cycle.

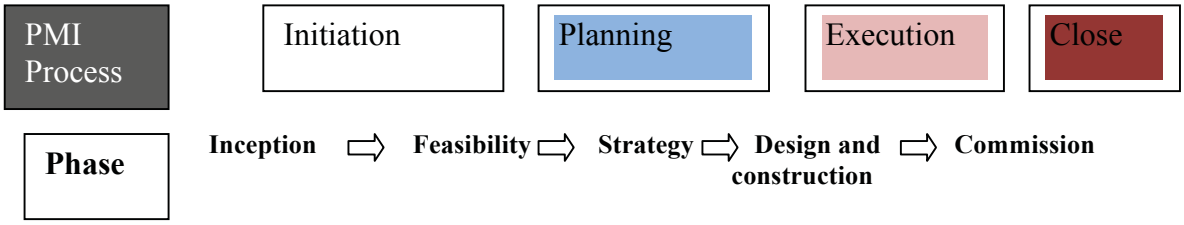

Figure 1: Project management process (Fewings, 2009)

2. Research on typical mistakes in the projects financed by the European Union in Latvia

Hundreds of thousands of projects throughout the EU have benefited from investment from regional policy over the years. For the 2007–13 period, Latvia has been allocated around € 4.6 billion in total, €4.5 billion under the Convergence Objective. This is nearly four times more than for the previous programming period, 2004–06.Latvia has three programmes: two supported by the ERDF and Cohesion Fund: 'Entrepreneurship and Innovations' and 'Infrastructure and Services', and one supported by the ESF: 'Human Resources and Employment'. All three programmes cover the entire territory of Latvia.

The financing available to the National and Regional Scale Development Centre Growth Promotion for Balanced State Development activity of the event Support for Sustainable Urban Environment and Urban Region Development of the supplemental priority Polycentric Development of the program Infrastructure and Services in the 2007–2013 planning period makes up LVL 209,216,720, including ERAF co-financing of LVL 177,834,211 and national public co-financing of LVL 31,382,509 (State budget grant), and as a consequence the reception and efficient administration of financial resources have become topical issues.

The above-mentioned financing is intended for encouragement of the regional development in the regions of Latvia, except for the capital – Riga. The financing is invested in the regional municipality infrastructure objects and the amount of one project is no less than EUR 1,000,000.

Regional development is a concept describing a very important part of nowadays public policy. If before regional development was defined and shaped in various ways at national level, today the European Union plays a significant role in regional development and policy

What is special about state projects is their direct relationship to the traits of a country as a decision-making subject. Apart from such traits as uniformity of the target of influence, state power, unification of double, triple and multiple standards, there is also a special context to be considered when working on state projects:

* Specific legal regulations, determining on one hand the activity of the whole society and on the other that of institutions undertaking the projects. The amount of such regulations is much greater than in business.
* Wide range of stakeholders and responsibility before the society, and the stakeholders can be both in and outside the reporting process. The internal stakeholders are state institutions, agencies, officials etc. The number of external stakeholders is greater - mass media, citizens, interest groups etc.
* Use of state resources to finance state projects from the state budget. This increases the responsibility of state officials and complicates it due to the difficulties of measuring the project success and manager's performance. It is also hard to assess the benefit that the project provides to the society, since it is sometimes impossible to apply such indicators as benefit-cost analysis

(BCA) or the return on investment (ROI). Officials normally use qualitative indicators to assess project efficiency and benefits.

The study of typical mistakes in public projects reveals that they can be subdivided into four major groups based on their influence on the mistakes:

- Project management
- Procurement
- Construction projects
- Accounting

Typical mistakes in project management:

- Incorrectly calculated resource needs on the project – financing, deadlines, people
- Missed project deadlines
- Uncoordinated extension of delivery deadlines
- Insufficient care taken to select cooperation partners
- Poorly planned cash flow
- Contractual terms not read and observed
- Expenses not matching estimates
- Contractual publicity requirements not observed
- Procurement from related persons
- No certainty of the economic advantage of chosen proposal
- Setting project goals that are not actually planned to be achieved during project
- Diverting from project goals during execution
- Lacking or only formal equal opportunities for the handicapped
- No price control
- No control over suppliers' promised deadlines, contractual penalties not applied

Typical mistakes in procurement:

- Insufficient preliminary research, and resulting poor technical specifications
- No market research, and as a consequence inappropriate price
- Insufficient assessment of the potential of unforeseeable expenses
- Exceedingly limiting requirements for candidates
- Equal competition and equal opportunities not ensured
- No opportunities for newcomers to enter the market
- Insufficient time allowed to prepare the proposals

Typical mistakes in construction projects:

- Low quality projects
- Insufficient care taken in preliminary research
- Not all work foreseen – especially in renovation and reconstruction of old constructions
- Poor construction supervision
- Insufficient care taken in filling construction supervision logs
- Contracts favour supplier, project manager has no right to apply sanctions in case of contractual delays or non-performance

Typical mistakes in accounting:

- Accounting methods do not describe project accounting procedures, which makes tracing and control more difficult
- Accounting does not comply with laws and regulations effective in Latvia – accounting principles, document formatting, business legality
- No information stored on requests for payment (RFP) preparation details
- RFP include data that does not comply with accounting procedure

- Project-related documentation does not indicate contract/project No. (double financing risk)
- No confirmation that the project manager control project execution and financing
- Documents are not stored in accordance with requirements of regulations and contract conditions (deadline, document nomenclature, storage place, registers)
- Document nomenclature does not foresee a required document storage time

Conclusion

Consequences of mistakes :

- non-conformance or financial corrections;
- withheld financing;
- penalties for Latvia.

These mistakes can be minimized by simplifying the system through preventive project control.

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Student Evaluations of Courses in Business Studies. A Validation of Eduqual Method.

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Abstract:
In our ongoing research, we intend to measure the quality of the process and outcomes of trainings (experience-based courses) offered at an economic and business administration faculty of a Hungarian university. A complex approach is adopted, defining competence development outcomes as the technical quality of the service, while students' evaluations of the delivery of these new types of courses as the functional quality of the service.
For measuring functional quality, we have used a SERVQUAL approach, adopting it to a course-level evaluation by students. In our preliminary analysis, a factor analysis was carried out to validate our scale, resulting in well-interpretable results, showing that trainings enable students to improve their competences and also that our scale for measuring the quality of the service delivery process is valid and shows a good functional quality of our courses.

1. Introduction

According to higher education experts, the most important consequence of the Bologna reforms will be a modification of education paradigm throughout the whole continent. Institutions will slowly shift from a teacher-based concept of education to a student-based one, which is more appropriate to meet the expectations of mass education (Alfassi 2004). Students who are increasingly considered as customers of the education service further reduce power asymmetries (by, for example, student opinion polls), and change the previously dominant student-teacher power relations (Morley 2003). In addition, it is also due to an increasingly competitive higher education environment that institutions, department and course managers consider service quality a highly important issue. In this sector, it may have long term effects for both the student and the institution, as it may influence student recommendations as well as their future monetary support (Lelanc and Nguyen 1997).

These processes have led us to devise a research planned for the long-run about the outcomes of putting competence and skill development into practice. An important methodological issue in this field is how to measure competence and skill development. In addition, the questions of how students accept the new methods of teaching (experience-based, small-group trainings) and of what their opinions are about this have arisen. For this, a survey of two directions has been planned: we are measuring competence development of training courses, as well as students' perceived quality and satisfaction of them. In this paper, we present the early results of the latter subtopic.

1. PERCEIVED QUALITY IN HIGHER EDUCATION

The main objective of the presented part of our research therefore is to answer how students' perceived quality and satisfaction can be measured in connection with skill-developing trainings, and what are those dimensions of this specific education process that are important in their satisfaction. Thus, in this section, we review the theoretical background of service quality measurement, specifically in a higher education setting.
The questions presented above have led us to think about higher education outcomes complexly, realising that the difficulties of evaluating the quality of services evidently applies here. The quality of the service (in our case, university courses of training) has different meanings for different people; for service providers (in our case, the institution and the teachers or instructors of the trainings themselves) and for customers (in our case, the students).

1.1. Dimensions of service quality

As providers and customers have different knowledge and often there is an information asymmetry between them, we may differentiate between technical and functional quality. Technical quality relates to what has been provided during the service process, while functional quality relates to how the service was provided (Grönroos 1982). In our consideration, this approach can certainly be applied in higher education. Technical quality refers to what competences are addressed during a training or other university course and the efficiency to achieve the development of these competences. Functional quality, on the other hand, refers to how these competences are developed: it is the environment, the instructor, the method of teaching and student experiences: the process of the training which is important. We suppose that students' perceived quality of the service is affected by functional quality, while technical quality is related to the longer-term value of their knowledge and skills, often evaluated at the labour market, years after graduation.

1.2. Research of perceived quality in higher education

Cuthbert (1996a, 1996b) used a modified SERVQUAL questionnaire in order to make it applicable in a higher education setting, with only the minimum necessary wording

changes to preserve reliability. With a sample of 134 respondents, the results suggested a significant modification of the factor structure compared to the original theoretical structure. The author's main suggestions include to revisit the dimensions used in higher education courses, as service experience presumably is a more complex assessment in this field compared to banks or restaurants, as students' encounters last for weeks or months. Also, it is important to consider according to him that although service provision encompasses administration, computer services or library facilities, the peculiarity of the course as a service requires a development of a new instrument that focuses only on those elements of quality that are under the control of the course manager.

Tan and Kek (2004) used an adapted version of the SERVQUAL scale, consisting of 76 attributes classified into eight factors of service quality in education. On the basis of 958 responses from two universities, the authors found that a significant reduction of the attributes as well as dimensions is needed, and that the instrument is applicable in measuring gaps of perceptions and expectations of students.

Lupo (2013) successfully used a university-level SERVQUAL approach (with dimensions of academis staff, infrastructures, equipments and aupport services) for identifying the service main Gaps and a suitable ‘‘Gaps oriented’’ strategy for the overall service quality improvement has been found.

2. METHODOLOGY

At this phase of our research, we intended to validate a scale for measuring perceived quality and satisfaction with courses, and if the instruments proves to be valid, to receive information about the gaps of quality. Being at the beginning of the research, we considered diverse types of university courses (trainings, seminars, lectures) as we intended to develop an instrument that is appropriate to measure the course-level quality of all our courses. We have therefore developed a SERVQUAL tool (that may be called EDUQUAL) and used it to capture the course-level perceived quality of the courses – to measure students' perceptions. We have adapted the SERVQUAL approach due to its ability to generate information on not only the evaluations of the actual service, but also about the expectations of students. Compared to the original scale, we have devised a significantly modified version of it, as higher education courses differ significantly from those types of services that were originally measured by the model. Nonetheless, we have managed to preserve the content of the five original dimensions, and have formulated 24 statements to be evaluated on a 5-point Likert scale. In this process, we put an emphasis on using items that are under the control of the course manager. In addition, we used 4 items for measuring student satisfaction:

- perceived importance of the course content for the career of the student,
- the course worth the need to pay tuition fee for the education,
- the teacher's education method increased the student's interest towards the topic,
- overall satisfaction with the course.

For the SERVQUAL evaluations, our sample consisted of 181 respondents (of which 36,5% are males and and 63,5% are females) which was divided among 4 teachers and 12 courses, both training-and non-training types.

3. RESULTS

In order to validate our adapted SERVQUAL instrument (EDUQUAL) and to identify dimensions, a factor analysis was carried out to validate the gap scores (perceptions minus expectations for each items). A principal component method and VARIMAX rotation were used. The factors we identified were different from those indicated in the theoretical model, but in majority are well interpretable and were able to explain approximately 65% of the total variance, which is a good result compared to other ones in this specific field.

The factors identified are the following:

- Cooperation, refering to the atmosphere of the classes and the level of partnership in the relationship between the teacher and the students.
- Reliability of teaching method, which refers to the way knowledge is trasferred and whether the teacher takes the students' needs into consideration.
- Assurance and punctuality which refers to an accuracy of the administrative and professional sides of the teaching process.
- Empathy, partly referring to meeting students' needs (this dimension is somewhat more ambiguous compared to the other ones, as items belonging here are not so compatible)
- Tangibles, refering to the physican environment as well as the appearance of the teacher (Table 2).

When controlling the reliability of the above described dimensions, it was found that that of Cooperation, Reliability of teaching method, as well as Assurance and punctuality are good, whereas Empathy (as suspected) and tangibleas are lower.

TABLE 2
Factors of perceived quality

Factors (Chronbach's alpha reliability)	**Items**	**Factor loadings**
Cooperation (0,822)	informal style of communication with students	,807
	communication with students as an equal partner	,760
	when a problem occurs, the teacher deals with solving it	,615
	the classes take place in an agreeable atmosphere	,576
	the teacher really holds the interest of students in mind	,575
	the teacher is polite with the students	,530

	the teacher pays attention to the comments of the students	,519
Reliability of teaching method (0,779)	the teacher adapts to the knowledge of the group	,764
	the teacher cares about transferring the knowledge in an interesting way	,709
	the teacher cares about transferring the knowledge in an understandable and transparent way	,707
	the course will give up-to-date knowledge	,616
Assurance and punctuality (0,832)	at the course, evaluation is clearly linked to performance	,703
	when the teacher promises something for a certain time, it will be accomplished	,652
	the teacher always takes time to respond to requests, questions	,559
	the teacher does not make professional mistakes at the classes	,555
	the teacher is always available at previously given or agreed times	,532
	the teacher adequately administers the fulfillments	,483
	the teacher provides appropriate aids for studying	,448
Empathy (0,625)	the teacher keeps the classes exactly according to the schedule	,762
	the teacher pays individualized attention to the students	,674
	the teacher can answer administrative questions concerning the course	,597
Tangibles (0,659)	the teacher uses modern tools in the classroom	,786
	the teacher's appearance is pleasant	,621
	the aids (e.g. ppt's, handouts) used by the teacher are visually attractive	,579

Source: Own construction

When calculating the gaps between the perceptions and expectation of students (means of evaluations, Figure 1 and 2), we found that there were only marginal gaps, and these were positive at most of the cases, indicating a good quality of service delivery. The results also show that both expectations and perceptions get high ratings. The lowest (compared to the other factors) expectations and evaluations belong to the dimension of tangibles, while other dimensions seem to be equally important.

Our results also showed that there were significant, but moderate correlations between most of the factors and overall satisfaction (Table 3). Further calculations of correlations between factors and satisfaction showed that there is a significant correlation between the Reliablity of teaching method and perceiving the course worth the need to pay tuition fee for the education (0,511, $p<0,01$). The exception was the factor of Empathy, which seems to be a little bit problematic – this was the most difficult to give a name to, too. For future research, it will worth consider modifications in the scale.

TABLE 3
Correlations between perceived quality factors and satisfaction

Factors	Correlation with overall satisfaction
Cooperation	0,464**
Reliability of teaching method	0,475**
Assurance and punctuality	0,473**
Empathy	0,134
Tangibles	0,364**

Note: ** Correlation is significant at the 0.01 level (2-tailed).
Source: Own construction

It is not evident how to measure a higher education institution's course-level service quality. With the intention to grab functional quality, we developed a scale on the basis of SERVQUAL methodology to measure student evaluations of the process of teaching. Our early results show that this approach may be appropriate for such evaluations, however, further modifications and tests are needed to improve the validity and reliability of the scale. Nevertheless, our results showed a good functional quality of our courses.

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Designing Smart Systems: Developing the M2M Smart Systems Readiness Canvas

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Abstract
Machine to Machine communication and the smart solutions associated with it have been under focus in recent years, due to the fact that M2M smart solutions enable companies to offer new, enhanced, and more cost efficient services.

With the rapid increase in the number of machine connections, it becomes more and more important for companies that want to maintain a competitive edge and countries that want to lead in technological development to adopt and develop M2M solutions and smart systems. The adoption of M2M solution mandates a number of prerequisites that include strategic, technical and socio-economic requirements. In order to understand these requirements better, there should be a thorough analysis of M2M components, characteristics, applications and value chain.

This paper presents an evaluation framework, the 'M2M Smart Systems Readiness Canvas', that studies the different prerequisites needed on a national level in any country for the successful adoption of M2M smart solutions.

1. Machine-to-Machine and Smart Systems

Machine-to-Machine (M2M) Technology is the concept of machines using network resources to communicate with remote application infrastructure for the purposes of monitoring and controlling the machine itself or its surroundings (ABI Research, 2010, p. 4). Rouse (Machine-to-Machine, 2010) provides a broader dimension to the concept to include any "technology that enables networked devices to exchange information and perform actions without the manual assistance of humans."

According to an ABI Research (2010) sponsored by Cisco, mobile machine-to-machine (M2M) market is expected to grow globally from approximately 71 million connections in 2009 to roughly 225 million connections by 2014.

In its simplest forms, any M2M communication has three components *(See Figure 1)*:
a) an M2M device, contained in an asset (a physical object or a person) to collect data or control the asset, which can either be stationary or moving.
b) a gateway that links to a network and provides data communication (wired/wireless) between a device and a platform. This gateway can be integrated with the device.
c) a platform (device) with computing software (applications and databases) to analyse the data and make decisions, e.g. a personal computer .
(Rouse, 2010) (Crosby, 2013) (Umate, 2013)

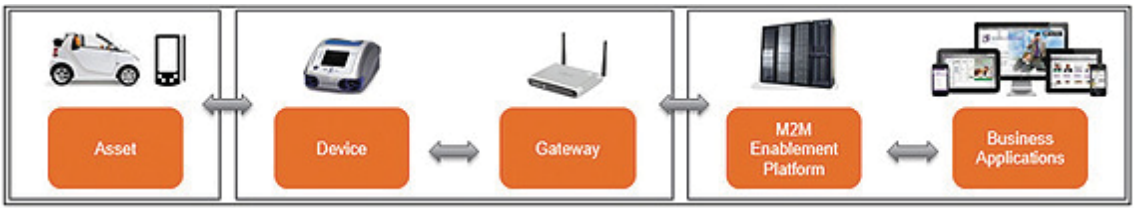

Figure 1: M2M Key Components (Umate, 2013)

The concepts of M2M and Internet of Things are often confused despite obvious differences between them when it comes to devices, precedence and social networking. The Internet of Things (IoT) is the network of physical objects accessed through the Internet. These objects contain embedded technology to interact with internal states or the external environment, changing how and where decisions are made, and who makes them (Cisco, 2014). M2M devices have embedded connectivity, while the Internet of Things tries to include all objects, even with no embedded connectivity within its network, e.g. using bar codes and RFID. M2M precedes IoT as a concept and therefore for the successful implementation of IoT, standardization and connectivity issues of M2M must be solved first, making IoT depending on M2M. Finally, moving all this connectivity to social networking platform gives a leap from M2M to IoT. (McLellan, 2013) (Zujewski B. , 2014)

Machine-to-Machine (M2M) systems are the starting point for smart trends. Its successful implementation lays the ground to the development of the Internet of Things and to other "smart" concepts such as Smart Systems. Smart Systems are systems that provide real-time information based on inputs from machines, people, video streams, maps, newsfeeds, sensors, and more. They include hardware, software, network technologies and managed services. They integrate people, processes and knowledge thus enabling collective awareness, creativity and better decision making (Harbor Research, 2013). With the intersection and integration of M2M and smart systems, new ways of collaboration and intelligence will result. According to Harbor Research (2013), this introduces the concept of "Smart Business" which eventually will enable a truly connected world. (Harbor Research, 2013)

2. M2M Sector Areas

The applications of Machine-to-Machine technology are many and fall into several areas. They can be categorized into nine sector areas, as follows: (Beecham Research Ltd., 2011)

a. Buildings: composed of commercial and industrial segments, covering shops and supermarkets, office buildings and government departments and buildings housing factory processes. One example is the smart office.
b. Energy: composed of tools for power generation and distribution for both traditional and renewable energy sources, power quality and energy management and tools for extraction and transportation of commodities. Major examples in this sector are smart grids, smart metering and Big Data analysis for energy production and consumption.
c. Consumer & Home: composed of infrastructure tools such as wiring and networking, in addition to safety and entertainment tools, such as fire alarm, climate control, home security, etc. An example of this is the Smart Home.
d. Healthcare: composed of tools for patient care in hospitals, clinic and homes, such as medical home monitoring systems and implants. But M2M applications in healthcare are not limited to patient care; it also includes research aid tools such as drug discovery and diagnostics. An example for this sector is Ambient Assisted Living.
e. Industry: composed mainly of industrial asset monitoring and tracking that includes fluid management, distribution and resource automation. With the development of M2M

solutions in the industry sector, the world heads towards the fourth industrial revolution, or 'Industry 4.0' where production becomes individualized.

f. Transportation: composed of vehicle and non-vehicular telematics, navigation, tracking and recovery, in addition to transport systems covering passenger information services, pricing and parking schemes, etc. Most important examples in this sector are Car2X and V2G
g. Retail: composed of tools for stores and distribution centers, in addition to hotels, restaurants, etc. The main example in this case is RFID.
h. Security: covers tools for emergency services, surveillance, tracking and delivery, public infrastructure such as water and climate and finally military gear and equipment. (Beecham Research, 2013)
i. Networks and IT: covers tools remote monitoring, public networks and for enterprise networks and office equipment such as printers and copiers. (Beecham Research Ltd., 2011) (Keßler, Bogenfeld, & Kurz, 2011)

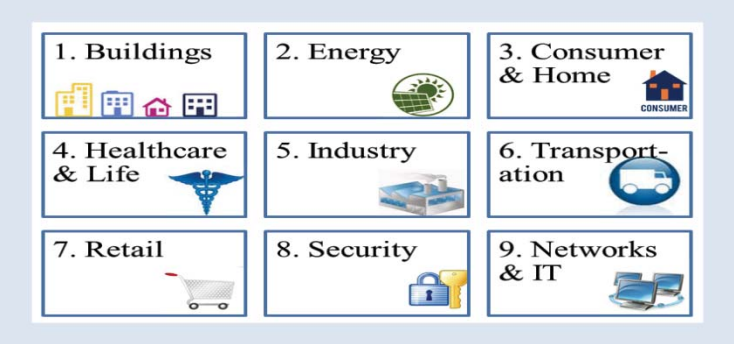

Figure 2: M2M Sector Areas (modified) (Beecham Research, 2013)

3. M2M Value Chain & Environment

In order to understand the basic requirements for the set-up and adoption of M2M technology and trends, it is essential to understand and analyze the M2M value chain and environment in order to evaluate the adoption readiness of the stakeholders involved.
Through the analysis of several value chain examples from leading companies in M2M solutions, such as Vodafone (Vodafone, 2013), Deutsche Telekom (Deutsche Telekom, 2013), Telit (Telit Wireless Solutions, 2013), Wyless (Wyless, 2013), etc., the most important components of an M2M value chain become obvious. Although the different value chains differ in size, labels, needs and core businesses, their integration provides the components:

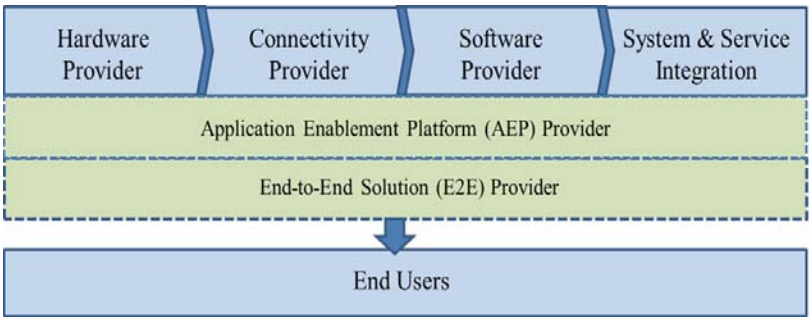

Figure 3: M2M Comprehensive Value Chain (own drawing)

a. Hardware Providers: Device and module manufacturers produce and sell M2M devices, with built-in modules that enable connectivity, allowing machines, equipment, vehicles and devices to communicate over a network. The challenge is to provide devices that incorporate and cover

the wide range of needs for M2M communication such as physical robustness, energy efficiency, communication and network security and wired or wireless services. Hardware providers' role extends to include providing Machine Identification Modules (resembling a SIM card, MIMs identify machines, equipment and devices in the Internet of Things), module management services and sometimes subscription management services. They also work to customize hardware to the needs of the customer application. (Telit, m2mAir, 2013) (Telecompaper, 2008) (ITR Manager, 2008)

b. Connectivity Service Providers (CSPs): Mobile Network Operators (MNOs) and Mobile Virtual Network Operators (MVNOs) have taken the lead in trying to organize and rationalize the value chain to facilitate and simplify overall M2M development/deployment. Due to this, M2M connectivity providers' role has been extended much further than mere connectivity. MNOs and MVNOs benefit significantly from the fact that they already own the existing technology needed for providing M2M services.
CSPs offer SIM cards, M2M rates and billing services, quality, testing and IT security and finally, service level agreements (SLAs). They may contribute in, have partnership with or completely take over the role of the Application Enablement Platform (AEP) provider. (Viswanathan, 2012) (Telco 2.0 Research, 2011) (Deutsche Telekom, 2013) (Vodafone, 2013) (ABI Research, 2010)

c. Software Providers: There are currently two main methods in the M2M market for software development:
1. An Application Service Provider (ASP) designing M2M applications and customizing them for customers. It also offers a complete M2M platform and deals with different customers to enable M2M functionality as they require.
2. Due to the fact that the technical details and network infrastructure deployed by CSPs directly impacts the capabilities of an ASP in such areas as rapid service creation, ensuring Quality of Service, and enabling granular management and diagnostic tools, a tight collaboration between CSPs and ASPs is needed. It might either be done through a partnership or CSPs incorporating software development in their business units (ABI Research, 2010). Deutsche Telekom and its M2M Developer Community have developed an M2M app store offering users the ability to browse and view the different Business-to-Business M2M solutions that Deutsche Telekom offers in different sectors, such as Automation, Government, Healthcare, Logistics, etc. (Deutsche Telekom, 2013)

Regardless of the method used, the trend by both software providers and connectivity providers is to offer Software Development Kits (SDKs) and Development Platforms to everyone who wants to take a look or try to develop M2M applications and participate in the community. These kits include SIM card(s) with test duration, specific volume allowance, defined storage and defined network coverage, also possibly a module. (Developer Garden, 2013)

d. System & Service Integration: System integrators and providers of additional integrated services for M2M solutions are also important members of the M2M value chain, even if their roles overlap with some of the members already discussed.
System Integrators and external service providers deliver value to companies by enhancing business processes and integrating machine data into the enterprise. This is important because M2M projects are very large and complex in scope. Additionally, professional consulting and integration services, Big Data & Analytics tools and billing and payment services would be needed to complete an M2M solution. (Zujewski, 2013) (Yaacobi, 2013) (Deutsche Telekom, 2013) (Vodafone, 2013)

e. End Users: End users of M2M solutions can be businesses or individuals, taking different business models of B2B, B2B2C and B2C and ranging between the different M2M service

sectors. M2M implementation should ultimately provide end users with differentiation for their products or services. It should not only help them reduce costs, but give them the ability to transform their business and reinvent the user experience of their own customers. (Zujewski, 2013)

Value Chain Members originating from New M2M-specific Business Models

f. M2M Application Enablement Platform (AEP) Providers

M2M Enablement Platforms are "software systems designed to streamline M2M applications development across multiple verticals" (Dawson, 2012). A unified and holistic M2M Enablement Platform can help companies better monetize M2M through:
1. transforming them into a one-stop shop for their M2M partners, with the flexibility to provide each partner with exactly what they need, from simple IP connectivity to more complex partner and device management.
2. creating a richer network of ecosystem partners and delivering a superior experience to the end customer.
3. accelerating time to market and M2M development with pre-integrated hardware, embedded application frameworks, network operators, and cloud applications and without any on-premise IT infrastructure. (Yaacobi, 2013)

M2M Enablement Platform enables users to set the management rules for their M2M platform, allows for terminal management, remote automation, notification and user-defined fault handling strategy, includes tools for users' subscription management and administrational operational management and finally uses data captured from devices to perform real-time analysis, generating reports and providing insights that can help optimize business management to eliminate extraneous costs and increase revenue. (SingTel Corporation, 2013) (Datang Corporation, 2013)

g. End-to-End Solutions

M2M solutions require consideration of the entire process chain, from the connection of devices to the integration into the IT infrastructure. For this purpose, it is necessary to understand the business processes, to take into account all the requirements and to choose the right components requiring the participation of several companies for a complete end-to-end solution. A single company usually offers services around its core business, and then works with partners for an integrated result. (SyroCon Consulting, 2013)
A complete end-to-end M2M solution includes offering M2M modules with device management software, M2M connectivity, M2M data analysis and management, M2M applications, M2M integration framework and added services such as subscription and billing management. (Axeda Corporation, 2013)

Environment surrounding the M2M Value Chain

In addition to the elements of the M2M value chain, there are a few other players in the M2M ecosystem who do not have a direct input in the creation of value from M2M solutions, but do aid in the success of the entire ecosystem:

1. Government and Regulatory Bodies: Local government and political unions can have an immense impact on the development and adoption of M2M Solutions. The role of such regulatory bodies is essential in solving issues such as numbering, identification codes, roaming rules, open source application development, etc. (ABI Research, 2010) (European Commission,

2013) (Robinson, 2013). There are many efforts on a European level, such as the European Telecommunications Standards Institute (ETSI) and on an international level, such as the Third Generation Project Partnership (3GPP) who have put tremendous efforts into M2M standardization. These cover architectural components, data exchange, products, services and sector-related standards. This helps in reducing the time, complexity and cost of developing and deploying new M2M solutions. (Keßler, Bogenfeld, & Kurz, 2011) (ETSI, 2012) (Clarke, 2012)

2. Universities and Innovation and Research Centers: M2M projects can be found in a vast number of fields: architecture, construction, engineering, communications, cellular, medical and environmental (European Commission, 2013). Many efforts have been put to involve universities, professors and students and benefit from their young minds and innovative ideas. Research centers have helped understand the M2M technology, its feasibility and future outlook by offering forecast reports of the M2M market opportunities and qualitative issues shaping the market. (Beecham Research, 2013) (Machina Research, 2013)

3. Companies whose core business falls within M2M service sectors: M2M applications extend among a wide range of service sectors, from retails to energy to healthcare, etc. In order to create successful M2M solutions that precisely fulfill customer requirements, it is crucial to involve companies from all these sectors when developing solutions.

4. Manufactures of Machinery and Appliances: Manufactures of factory machinery, cars, and home appliances, for example, should have an understanding of the potential of M2M Solutions in order to embed the new and competitive features in their products.

4. M2M Characteristics and Influential Factors for the implementation of M2M Smart Solutions

Machine-to-Machine communication is characterized by a number of technical features such as real-time data, high data processing, small amounts of data transfer, need for high data security, confidentiality and integrity. Data shall be transmitted in some applications only when needed, in other cases it shall have continuous and regular connectivity and real-time data exchange. Therefore, it should allow for different connectivity modes such as Wi-Fi, GPRS, 3G, LTE, radio waves, etc. These features also require reliable hardware characterized by long battery life, device discovery, remote management and high endurance (Internet of Things - Architecture, 2011-2013) (Juniper Networks, 2011).

Efforts to ensure standardization and compatibility are inevitable; to regulate how hardware modules, network and data exchange protocols and software platforms from different solutions will interact together.

However, M2M characteristics are not limited to the technical features. As any innovative technology, its implementation entails a socio-economic change process, which should be implemented carefully to ensure a smooth adoption. It requires innovative business models and value chain roles, re-engineered business processes, new strategic alliances and partnerships and a holistic ecosystem that includes necessary infrastructure, partner companies, governmental initiatives or subsidies. This ecosystem will help strengthen efforts and alleviate financial burdens related to the implementation of M2M smart solutions.

Thus, several factors influence the adoption and implementation of M2M smart solutions. They can be categorized mainly into technical, organizational and long-term planning and socio-economic. This lays the basis for analyzing the M2M smart systems readiness.

5. M2M Smart Systems Readiness Canvas

As enterprises always strive towards having a competitive advantage over other rivals in their sectors and constantly attempt to lower costs while increasing efficiency, there is an international tendency towards the adoption of M2M solutions towards the design of smart systems, e.g. smart metering for energy companies, remote monitoring for transport companies, etc. (Baburajan, 2014). However, a single company on its own in any given country cannot achieve any significant shift towards the adoption of M2M smart solutions without being supported by a country-wide effort; thus making it crucial to create a framework that aims towards understanding and evaluating a country's position in this aspect.

The Readiness Canvas for the adoption of M2M smart solutions is composed of three categories and should cover a number of questions about each category:

Figure 4: M2M Smart Systems Readiness Canvas (own drawing)

1. Strategic and Regulatory Readiness:

This category deals with evaluating strategies and laws set by the ICT governmental institutions. It should answer the following questions:

- *Is M2M adoption and the shift towards Smart Systems part of the ICT governmental institution strategy?*
- *Are there laws to regulate the exchange of data, to protect the security and integrity of information and at the same time ensures equal investment opportunities for large ICT companies and SMEs? If laws are not present, how long does it take to issue such laws and how complex is the process?*
- *What standards exist for the development of M2M-specific hardware, software and to meet the connectivity needs? How are standards developed in alliance with other international standards? Is there a country-level standardization organization? Does the country belong to any regional or international standardization organization?*
- *Are there research centers or university partnerships to support the research and development in the area of M2M-specific requirements and smart applications?*

2. Technical Readiness:

This category deals with the ICT infrastructure of a country. It covers the following questions:

- *Is the country able to produce or import necessary equipment, devices and sensors for M2M smart solutions, with long battery life, high endurance and remote management features such as smart meters for electricity, water and gas, video monitors for surveillance, control systems for remote control, etc.?*

- *What kind of connectivity is available to connect devices together and ensure that data moves from where it is produced to where it is needed? For example, are there citywide Wi-Fi networks, 3G/4G cellular networks?*
- *Is it possible to develop M2M smart applications locally? Is it possible to create M2M platforms for the management of M2M smart solutions? If not, is outsourcing an option?*
- *What standards exist to ensure compatibility and interoperability when it comes to hardware, software and connectivity methods?*
- *What kinds of technologies, policies or practices exist to safeguard data, privacy and physical asset, e.g. are privacy rules published? Are cyber-security systems implemented?*
- *How is data value and integrity preserved? How is it stored, protected and processed?*
- *How is data analyzed? Are there data analysis centers? How are predictions and preventative actions made based on this data? What kind of servers is being used?*
- *Are there any country-wide implemented systems that support that implementation of M2M smart solutions, e.g. GIS?* (Smart Cities Council, 2013)

3. Socio-economic Readiness:

This category deals with people and economy factors, meaning companies that adopt M2M smart solutions and customers that use them. It should answer the following questions:

- *Does the government have adequate budget to allocate to the adoption, implementation and further development of M2M smart solutions? This can be done either through building specialized governmental institutions, by supporting local companies through subsidies or by outsourcing part of work to lower cost countries.*
- *Are there companies in the country that cover the different roles along the M2M value chain?*
- *Are companies and customers educated about the benefits of M2M and its several applications?*
- *Do companies have the necessary qualifications and maturity to implement the technical and business aspects of M2M solutions?*
- *Are companies willing to form strategic partnerships along the M2M value chain in order to offer complete end-to-end solutions to customers?*
- *Are there any factors that would cause company staff to resist the change towards M2M solutions, for example is the company staff reluctant to cooperate and form strategic partnerships/ventures with other companies along the M2M value chain?*
- *Are there any factors that would cause customers to resist the change towards M2M solutions, for example do they have unsolved security or privacy concerns?*
- *Are there any social, economic or political factors that may contribute to the success or failure of the adoption of M2M smart solutions?*

6. Conclusion and Further Research

With the world tendency towards the adoption of M2M smart solutions, more light should be shed on preparing the necessary prerequisites for this adoption. This applies to a wide range of organizations, including those who set nation-wide ICT strategies and regulations and build its ICT infrastructure, companies that offer services along the M2M value chain and that contribute in applications along the M2M service sectors and finally the customers of such applications.

The proposed framework is conceptual and is still open for further research and improvements. It can be empirically applied to different countries who have already adopted smart systems. However, an interesting outlook into further research in this field is to apply this framework to a country like Palestine, where the political, social and economic difficulties might prove challenging for the adoption of such high technology and would require additional measures for its success.

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Design Process for embedded Systems

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Keywords: System Design, System Architecture, System Model, Use Cases, System Context, CONSENS, Test Strategy, verification, validation, V-Model, Integration Test

Abstract: This contribution deals with a systematic design process in the early stage of the development of embedded systems. It takes the complexity of mechatronic Systems into account and enables the domains to start their development with a consolidated view on the product. The process also enables the integration and test activities to participate in this early stage as well.

1. Introduction

Today, many products become more complex regarding the integration and testing of mechanics (ME), electric hardware (HW) and software (SW) as well as their interfaces. Therefore, a structured method is needed to ensure overall understanding of the system by all stakeholders in a very early stage of product development. By dividing the system, it is easy to handle tasks in order to start the domain specific development.

2. CONSENS

CONSENS stands for CONceptural design Specification technique for the ENgineering of mechatronic systems. It is mainly applied to the upper left corner of the V-Model (Figure 1), during the Requirements Engineering process. The CONSENS technique can be recorded as a "card game" during a workshop with the main stakeholders or with MS Visio® or EA® plug-in for documentation purposes.

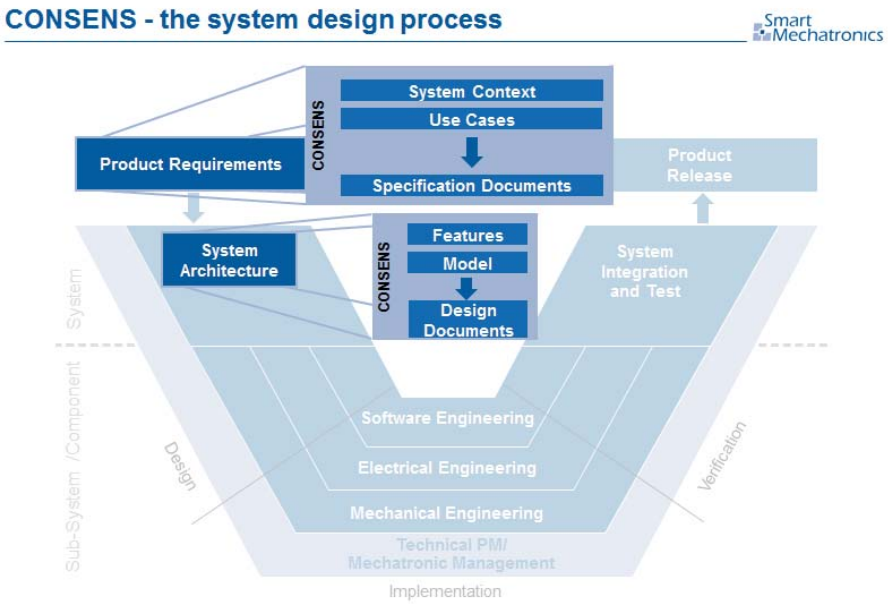

Figure 1: System Design

The idea behind CONSENS is to transfer the first product idea to a technical specification. Therefore, a systematical approach is described to develop specifications, requirements, use cases, system context and functions into a complex system architecture.

a. System context

The first step of CONSENS is to describe the system context as a black-box view of the system. All actors are placed in the model and connected to the corresponding system interfaces by a specific flow, such as material, energy, information or disturbances.

The result is a complete system context diagram with a clear definition of the system boarders and system interfaces. Here, an analytic view of the environmental influence or impact on the system is given.

b. Use cases

The second step is to develop use cases [2] as a list of steps, typically defining interactions (from actors' point of view) between an actor and a system, in order to achieve a specific goal. This is typically done in a modeling language such as SysML or UML, but a textual description is also very helpful to get a complete picture of the system. The entire product life-cycle shall be taken into account to ensure that the complete system behavior has been regarded.

c. System specification

The collection of the system specifications is the next step in the CONSENS technique. For documentation purposes a variety of tools is available. Yet, but for small projects a simple table might be sufficient, depending on standards and guidelines.

The specifications shall be recorded in defined wording (Ref. SOPHISTen guideline for specification writing [3]) with testable values (including tolerances) and acceptance criteria.

d. System architecture

The system architecture is the last of the considered steps: a white-box view of the system describes its inner architecture. The same modeling language as for the system context is used to connect the system elements to the respective interfaces via the flows as described above. This model can then be hierarchized down to a detailed level required for each of the specific domains (HW, SW, ME). Thus, the specific development as well as the integration and test definition process can commence.

3. Test

Once the basic system design has been defined, the right branch of the V-Model (Figure 2) has to be taken into account.

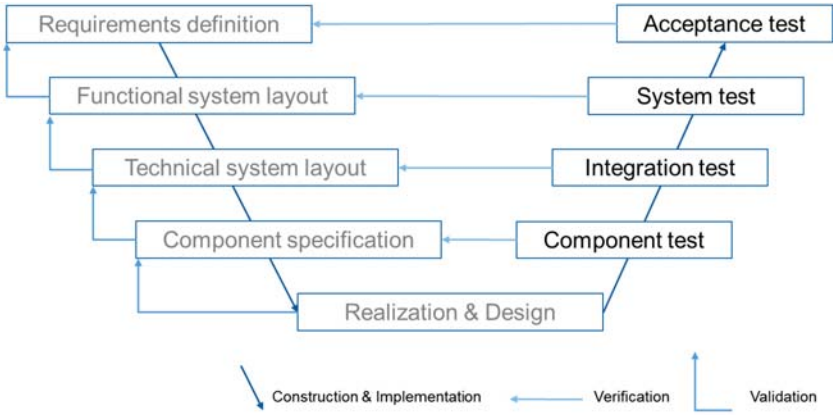

Figure 2: V-Model with emphasis on the right branch. Planning should start parallel to the left branch

Here, verification and validation are the main key words: Verification answers the question "Have we developed the product right?". Thus, the design and realization results are checked against the correct implementation of the requirements derived for the relevant level, but the intended use of the product is not taken into account explicitly.

On the other hand, validation answers the question "Have we developed the right product?". Here, the development results are checked against the intended use and therefore, the customer requirements. Usually the customer's acceptance criteria form the basis of the final validation. A typical test is always comprised of both elements with different emphases, since only one aspect alone is hardly ever possible. Yet, the validation part increases along the right branch of the V-Model. Thus, the component tests stage is dominated by the verification aspect, while the acceptance test usually is a nearly complete validation test.

It is important to understand, that the V-Model is not to be taken as a chronological but as a logical sequence: Every stage of the left branch makes an equivalent level on the right branch necessary. Therefore, a test strategy has to be defined early in the project, describing in general how each level will be handled and which kind of tests will be performed. Possible approaches here are requirement based, experience based or functional tests, for example.

Also at an early stage, templates for the documentation of the test specifications and test reports have to be defined. Level documents define a more detailed plan for each test level, including test criteria, the acceptance of which will be the final step within the test analysis at the end of each level. Further testing steps are: test specification, test execution, and test documentation. The specification defines the test sequence including the given inputs and expected outputs. Environmental conditions as well as pre- and post-conditions have to be taken into account and exit as well as acceptance criteria for each test have to be agreed on.

This procedure is then performed during the test execution stage. All relevant environmental parameters as well as outputs are recorded. The execution ends, when the exit criteria have been met.
The relevant outputs and all notable information are documented in the test documentation phase. Based on these documents it is checked, if the acceptance criteria for the test level have been met.

4. Results and Conclusion

The consideration explained in this contribution is a well-used technique to enable a smart start of the development. The CONSENS technique can be extended by several steps in order to integrate e.g. security and safety issues, depending on the focus of the project.
Experience shows that the higher effort made in the early stage of the project will be paid off by a faster development during the implementation phase and less changes throughout the entire project phase.

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Partitioning and Mapping for Embedded Mutlicore System Utilization in Context of the Model Based Open Source Development Environment Platform AMALTHEA

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Keywords: AMALTHEA, multicore, embedded system parallelism, model based software engineering, multi-os architecture

Abstract: This paper introduces various partitioning and mapping approaches in terms of model based embedded multicore system engineering and further discusses benefits and key performance indicators. Various industrial applications have been tested and developed among the AMALTHEA platform. Evaluations show that such applications improve significantly according to performance, energy efficiency, meeting timing constraints and covering maintaining issues. Furthermore, the model based design features an open, expandable, platform independent and scalable exchange format between OEMs, suppliers and developers on different levels. Our proposed mechanisms provide meaningful multicore system utilization since load balancing by means of partitioning and mapping is effectively performed with regard to the modeled systems including hardware, software, operating system, scheduling, constraints, configuration and more information. In addition three different types of multi-os architectures are introduced, followed by the description of the multi-os architecture, which was implemented in the AMALTHEA project.

1. Introduction

Increasing demands of assistant systems, safety issues, computational power, energy efficiency, AUTOSAR, product-line engineering or further requirements call for the need of multicore systems in the automotive and embedded system domain. To facilitate this process, there are known methods in order to distribute and map applications to a distributed or multicore system. However, most methodologies and environments lack in automatic, consistent and traceable processes as well as in comprehensive modularity and scalability. Our approaches are integrated to the AMALTHEA platform and meet most common requirements especially according to parallelism and program distribution in terms of model based design, representing program code in form of various abstract semantics.
AMALTHEA is an ITEA 2 funded project, which is developing an open and expandable tool platform for automotive embedded-system engineering based on model-driven methodology. Key features include the support for multi-core systems combined with AUTOSAR compatibility and product-line engineering. The resulting tool platform is distributed under an Eclipse Public License.
The AMALTHEA Tool Platform covers all **activities** for developing embedded software for multicore systems. During the requirements engineering (RE) phase, the requirements of the multicore system are gathered in an informal way. In variability modeling (VM), the software and hardware variability is defined. Architectural modeling (AM) focuses on the identification and representation of components and their interconnections. The behavior of each component is specified in behavioral and functional modeling (BM, FM), different modeling techniques can

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be applied depending on the nature of the component (e.g., Matlab Simulink, Statecharts, or plain C code). For these modeling activities and further configuration or specification all AMALTHEA data and information is stored within a **model environment** in order to provide a common and standardized basis among suppliers, OEMs and developers. Such models include software, hardware, stimulation, constraints, operating system, mapping, components, properties and events [1]. Besides the models and activities, the AMALTHEA platform further provides various features, integrated tools and interfaces to external tooling like the TA toolsuite [2], Damos [3], ETAS ASCET [4], Bosch TaskProc [5], AUTOSAR / ARTOP [6], EAST-ADL / EATOP [7], Matlab Simulink [8], Yakindu Traceability and Yakindu Como [9]. Integrated tools are ProR [10], Yakindu SCT [9] and the Variant Modeler and the integrated features concern transformations (from Damos, Como…), tracing, target mapping and both the partitioning and mapping features, that are described in the course of this paper. In addition a multi-os architecture has been set up for an AMALTHEA demonstrator. Therefore three types of multi-os architectures will be presented. Followed by the introduction of the ERIKA Enterprise multi-os architecture, that was implemented in the AMALTHEA project. Further information about AMALTHEA specific models, tools, features and activities are given in [11].

The paper is structured as follows. The next section reveals related work with regard to partitioning and mapping in context of model-based software engineering for embedded multicore systems. Afterwards, Sections 3 and 4 will describe the implemented partitioning and mapping features and algorithms. An analysis of multi-os architectures, which among others are utilized on the target hardware platform, is given in Section 5. Section 6 evaluates the proposed methodologies and discusses their advantages and benefits, along with key performance indicators. Finally, Section 7 closes this work and proposes possible future directions.

2. Related work

Over the years, several strategies for partitioning and mapping (embedded) software have been developed.
In [12] a simulation methodology for embedded realtime and cyber physical systems is introduced, which focuses on timing behavior as well as the combination of architecture properties and requirements. Each domain can be represented with specific computation models and recent work is addressing the multicore migration topic by means of specific algorithms.
Recent research featuring Augmented Hierarchical Task Graphs and several optimization techniques e.g. genetic algorithms and integer linear programming, has been described by Cordes in [17]. The author describes a parallelization framework, which integrates these techniques in order to perform an automated partitioning and mapping of software to heterogeneous hardware.

3. Partitioning

A Partitioning process in context of directed acyclic graphs (DAG), which occur in most computing applications as computation DAGs or task graphs, influences system performance. The more efficient the partitioning process forms computation sets distributed among computation units i.e. processors, the more the system benefits from time issues, energy demands or resource utilization in order to facilitate high performance real time applications. These aspects are common topics of interest in almost all areas of science and technology.

Forming computation sets mostly concerns the division of processes into subprocesses whereas each subprocess, mostly denoted as a node, consists of computational load [13]. A node often reveals directed communication with one or multiple other nodes, such that directed edges between them denote dependency. Having multiple nodes and various dependencies a directed graph can be derived. Since the partitioning approach considers parallel balanced sets for single

activations with respect to the topological order of the nodes, that directed graph has be transformed to be acyclic (DAG).
In terms of graph theoretical computing, partitioning such DAGs comes with a wide rage of problems and methodologies, spread across a variety of applications. Although many tools and algorithms have been developed for such purposes in the past decades, they are not fully applicable to embedded realtime systems due to their desktop-computer- or high performance focus.
A common problem is preserving the given orders of nodes. For single core platforms this is accomplished by assigning nodes to the processor with regard to the node's deadline (e.g. earliest deadline first). Such methods automatically preserve correct ordering of nodes such that no node is ever executed before its preceding nodes finished their calculation. According to multicore platforms, these methods must be significantly extended in order to preserve partial and total orders. Apart from approaches like logical- [14] or vector-clocks [15], that ensure these orders, but do not address the efficient assignments of nodes to processors, the partitioning approach in this paper addresses both, forming balanced node sets with minimal sequential runtime and minimal communication among different sets and the preserving of partial and total orders with embedded realtime system focus. For this purpose, periodic functions are modeled in separate tasks, such that any task only contains nodes with the same activation rate. Further, closely related functions are merged into one task to prevent unnecessary system overhead (context switches, data passing,…) via considering the critical path (CP), that provides the lower bound on the total time to execute a complete DAG [18]. Further tasks never exceed the CP's execution, or cause the CP to wait on input data (LGP = Local Graph Partitioning). Alternatively, an earliest deadline first (EDF) approach can be used, that considers node's deadlines only. Additionally, independent graphs can be identified and assigned to separate tasks.
Since several preliminary steps need to be performed before the actual partitioning can be executed, the following figure 1 outlines the activation analysis, label analysis, cycle elimination and the partitioning approaches denoted as graph analysis.

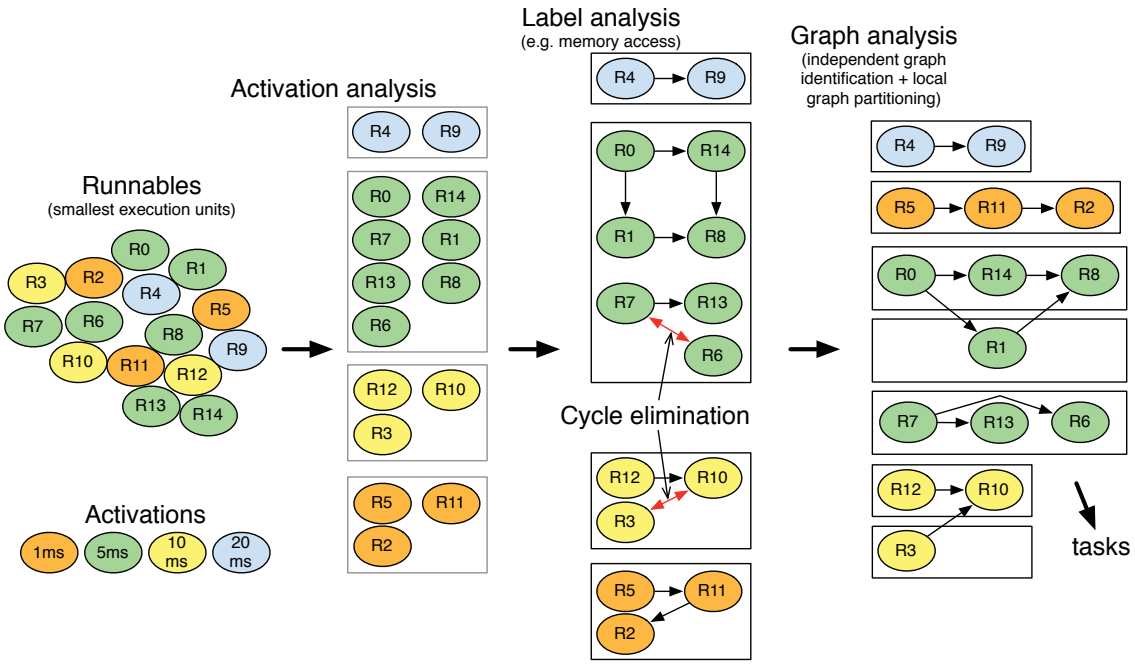

Figure 1: Partitioning levels

The label analysis features the identification of dependencies and the cycle elimination provides DAGs for the partitioning approaches. The cycle elimination features two important aspects,

since it is able to eliminate the lowest possible amount of dependencies on the one hand and to identify dependencies, which feature optimal resulting graph structures for parallelization on the other hand.

Two more features are implemented within the partitioning methodology, which concern the graph visualization with the help of Jgraph [16] applets and the generation of more flexible graph representation models, that can be used within the TA Toolsuite [2] in order to further analyze and optimize the models with the commercial tools.

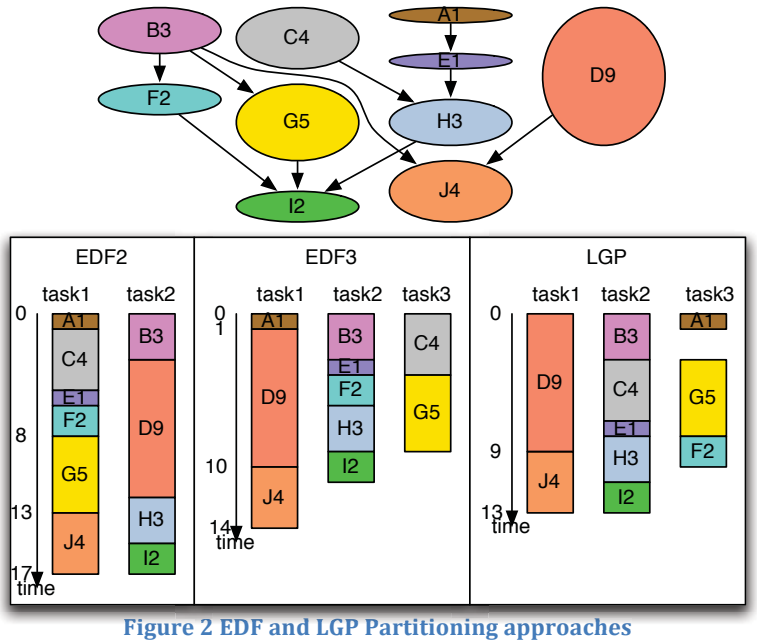

Figure 2 EDF and LGP Partitioning approaches

Since the partitioning approaches have been integrated to the AMALTHEA tool Platform, each previously described features and methodologies can be configured via the partitioning preferences within the platform.

The partitioning approaches require various calculations among the graphs, in order to gain information about deadlines and partial orders. DAG information is defined via the *span*, that is the length of the critical path and via the *work*, that is the sum of the node's execution cycles (instructions). The partitioning's result can be evaluated with regard to its *parallelism*, that is the sequential runtime divided by the parallel runtime, and the *slackness*, that is the factor by which the parallelism exceed the number of processors in the system [18]. However, Amdahl's law, that defines the *speedup* of a system via

$$\frac{Time_{before}}{Time_{after}} = \frac{1}{\frac{f}{K} + (1-f)} \leq Speedup_{max} = \frac{1}{1-f} = \frac{T_1}{T_\infty}$$

is still valid here and also used for assessing the partitioning's effectiveness. Since the LGP approach always considers the critical path as the most cost intensive task and creates tasks among the branches of the graph, it always creates ideal system partitions so that the best parallelism is created. However, since the EDF approach features a task number restriction and thereby has to go with losses, it is still able to create partitions that feature the best slackness factors. An example DAG with the corresponding Gantt chart partitions is given in figure 2. The figure outlines, that the LGP approach provides a greater load balance among partitions since total execution time can be reduced by one time frame compared with the EDF approach with three tasks. The EDF approach for two tasks features an optimal load balance among the two partitions.

4. Mapping

One of the essential and most complex steps during embedded multi-core system development is the mapping (or allocation) of software elements to components of the hardware platform, e.g. tasks to cores. Tasks of a software, for instance, should be allocated in a manner, that allows a concurrent execution on mutli-core platforms, in order to actually benefit from the

advantages of the multi-core platform. Moreover, additional constraints, such as meeting deadlines or avoiding concurrent access to shared (and limited) resources, have to be satisfied. Hence, as we can see, the goals of the mapping process can be described as finding an *efficient* and *valid* allocation of software elements to hardware components. The problem of finding such a mapping is called *mapping problem* [Foster1995] and known to be NP-hard.
The mapping problem consists of a variety of decisions. Apart from allocating tasks, data has to be mapped on the different types of memory, which can be located on a hardware platform or are attached to it. Conversely, a valid allocation can only be performed in consideration of a platform's data paths, since the communications and data accesses of tasks need access to the corresponding memories or cores. Besides the definition of allocations, the ordering of tasks is another very important step during the mapping process, which ideally minimizes the total execution time as well as opportunities for mutual exclusions and ensures the compliance of deadlines.
Several strategies for mapping software to hardware exist. Historically, the first specifications of allocations were done manually, e.g. by developers, who ideally followed guidelines that aim for efficient allocations [Foster, Gomaa]. The lack of computer aid however makes this strategy very error-prone. API's, such as OpenMP [tbd] and MPI [tbd] provide a possibility for a parallelization and mapping of applications by modifying their source code, require however experienced developers in order to gain a fault-proof and efficient parallelization. Mathematical programing (or mathematical optimization) aims at determining an optimal value for a function or variable, i.e. its objective function. This usually formulates a specific criterion of the embedded system, e.g. its energy consumption [tbd] or total execution time [tbd], in terms of a mathematical model, which is categorized with regard to its structure and constraints into e.g. integer linear programing (ILP). While this methods will determine, if existing, the optimal allocations, they also may take hours or even days for very complex systems. A more efficient approach to solve optimization problems is achieved by using heuristic algorithms.

The mapping approach implements both, heuristic as well as mathematical programming based mapping strategies, which are selected depending on the input models nature. This allows to balance between the accuracy of the resulting mapping and the required resources (i.e. computation time). Moreover, algorithms for optimizing towards different goals (optimization criteria) are implemented. A comparatively simple ILP based strategy for minimizing the total execution time is implemented in terms of a load balancing algorithm. The method bases on the well-known machine scheduling problem [tbd] and supports multiple heterogeneous processors with different execution times. The concrete execution time $cost_{e,c}$ of a task for a specific processor can be determined trivially using the following equations

$$cost_{e,c} = \frac{INS_e}{IPS_c} \; \forall \; e \in Runnables, c \in Cores$$
$$IPS_c = IPC_c \times PS_c \times f_c$$

with e being the set of a tasks *runnables* and c being the set of a platforms *cores*, INS_e representing the number of instruction of a executable software e, IPC_c the core's c instructions per processor cycle, and PS_c as well as f_c the prescaler (scale) of the frequency resp. the frequency the core operates at.
Additionally, the mapping approach features an energy minimization mapping strategy [tbd], which performs task assignment to cores, task ordering and the selection of optimal voltage each executed task, without harming any deadlines. This strategy is a two-phased approach: In the first phase, and EDF (single core) or priority based (multi core) approach is utilized to order and allocate the tasks. The goal of this step is to reveal so called slacks between the tasks, which are used in slowing down the application without harming any deadlines. In the second phase, an ILP based model is used to perform the voltage minimization, i.e. the expansion of the

applications runtime at the benefit of minimizing the total consumed power. The time limit of the application is usually given by deadlines or its period (in periodical applications).

5. Multi-OS Architectures

As a part of the AMALTHEA project, different "Multi-Operating System Architectures" (MOA) have been analyzed in the context of automotive multicore systems. The general feasibility, conditions and requirements were the focus of this analysis. After a research of the three different existing types, a fourth MOA has been implemented on a asymmetric dual-core processor, the Freescale MPC5668G.
The *general feasibility* of such a system depends on different factors. For example there should not be a big amount of virtualization, due to memory requirements. Virtual systems do have always a higher demand of memory space than native systems. The memory access has to be secure, but should not cause a deadlock. Due to this criteria and the criteria that are described in the next passage, it is possible to get a pareto-optimal solution. That means that the different criteria depend on each other. For example, a dynamic highly virtualized system will not meet real-time requirements. And on the other hand an embedded real-time system can not have a high virtualization.
There are several requirements necessary to realize a MOA, which meets real-time characteristics. *Virtualized* systems initially are not designed for embedded systems, but for the server- and desktop-market. To reduce performance losses, the system should only contain minimal visualization. It is possible to use paravirtualization techniques to minimize the visualization overhead. A high-level virtualization uses a high amount of its sources for the visualization instead of the actual application. Additionally the *code adaption of the operating system* should be as low as possible. Otherwise incompatibility may occur faster in case of an update. Furthermore code adaptions can affect the timing behavior of the OS (Operating System). Moreover the *independent restart of an OS* is another significant point. In case of a failure in one OS the other OS should not have to restart. *Memory protection* between different OSes is another requirement. An illegal access to parts of the memory, that are not of the acting OS should not be possible. A mutual exclusion between shared memory must be given, otherwise access conflicts occur. Due to *real-time capability* the MOA should not have time-consuming administrative functions between the different OSes. Finally the *number of simultaneously running guest OSes* is an essential factor. Different implementation methods are able to realize various OSes on one Hardware. [20, 22] In the AMALTHEA project the Freescale MPC5668G has been selected to support two OSes, due to its two different cores.
In [20], three types of MOA are described. All of these types have their individual emphases. Below, these three types will be described and an example will be given for each of the types. A closer consideration can be found in [21]. *Type 1* is realized by using a VMM (Virtual Mashine Manager), such as Xen and VMWare Server. The VMM hosts a VM (Virtual Mashine) for each OS, where the OS or even more OSes can run on. In this approach all the OSes run as a guest OS. There is no host OS. Inter-OS-Communication (IOSC), memory protection as well as mechanism for a shared use of the periphery are delivered by the VMM. An example for Type 1 is DynOS SPUMONE [19]. On a MOA of *Type 2* the guest OS is running as a process on the host OS. This type can be implemented by a paravirtualized guest OS or the hardware will be completely virtualized by an emulator (e.g. QEUMU) on the host OS. L4Linux and Wombat are typical GPOS (general purpose operating system) and RT-Linus and Linux on ITRON [23] are typical RTOS (real time operating system) for a paravirtualized version. The host system provides mechanisms for shared use of the periphery as well as IOSC.[20] Finally, with *Type 3* there is a hardware near approach. Each OS can use all the resources of one CPU, since it is assigned to one defined core. There is no virtualization between the OSes, that is why all the processes of an OS are independent. There is one host OS that delivers mechanisms for shared periphery usage. Memory protection is hard to realize in this approach, due to the fact that the OSes operate in privileged mode. An example for this type is SIGMA System [20].

The AMALTHEA-MOA uses two instances of ERIKA Enterprise as RTOS, one on each core. The two instances of this open-source OSEK ("Open Systems and their Interfaces for the Electronics in Motor Vehicles"-specification) real-time OS were implemented for different purposes. One instance as calculation core, the other one as I/O core. This approach differs in comparison to the types introduced before (see Figure 2). As Type 1 and Type 2 need *code adaptions*, Type 3 and the ERIKA approach do not need an extensive modification. Due to the hardware near approaches, Type 3 and the ERIKA-MOA do not have a huge amount of performance losses as Type 1 and Type 2 have. An *independent restart of an OS* is possible for Type 1 due its high visualization. With two instances of ERIKA, it depends on the hardware if a support of an independent restart by each core is given. The ERIKA approach supports a limited *memory protection*, as Type 2 does, due to statical partitioning. The shared memory of the system is not protected. Type 3 has no memory protection and Type 1 has a high degree of memory protection due to the virtualization. However, architectures of Type 1 and Type 2 are not able to meet *real-time capability*, caused by the virtualization. Whereas ERIKA and Type 3 meet the real-time capability due to the hardware near implementation. Type 1 and Type 2 have the ability of *unlimited guest OSes*, where Type 3 and the ERIKA approach are limited. For a detailed study and the implementation of the ERIKA-MOA see [21].

	Type 1	Type 2	Type 3	ERIKA
Modification	✓	✓	×	×
Loss of Performance	✓	✓	×	×
Reboot	✓	×	×	❍
Memory Protection	✓	❍	×	❍
Real-Time Capability	❍	❍	✓	✓
Unlimited Guest OSes	✓	✓	×	×

✓ Yes × No ❍ Conditioned

Figure 3: Comparison of Multi-OS-Architectures

As already mentioned, the RTOS instances on the implemented architecture are separated. There is a communication core and a calculation core. This has the advantage, that there is no communication overhead while calculating. Furthermore, the hardware can be used optimal. For example, the calculation core has a FPU (Floating Point Unit) for faster floating point calculation. An unlimited number of OSes is not possible for the AMALTHEA approach, due to renunciation of large visualization layers to keep the real-time behavior of the system. In the direct comparison to the three described MOA, the implemented ERIKA-MOA is preferred, when real-time capability and automotive support (ERIKA is OSEK certified) is needed.

6. Evaluation

During the last years the power of innovation and the customer claims of the automotive sector diverted more and more towards integrated electronic systems. This development can be seen at security systems, but also in the field of comfort systems. The customer wishes for cars, which contain the best technological functionalities grow continuously.
Numerous sensors and technical developments open a wide range of possibilities for further ameliorations. The customer's behavior changes in the same way. The all-day used communication devices, such as cell-phones, have to be integrated into the car. More and more,

the customers are willing to spend money for such functionalities. On the one hand, this creates a high potential for all car manufacturers to gain new clients and to bond new ones. On the other hand there are also risks in the development of electronic systems. They can be seen by moving the focus towards the product construction process of the manufacturers and their suppliers.
They have to deliver a product under aggravate conditions. The three objectives cost, quality and time have to be fulfilled as good as possible. Therefore, it has to be looked for new ways, methods and tools, which enable the manufacturers and suppliers to make their actions more efficient. In the case of software development for the automotive branch, the usage of a hardware-platform for multicore systems has to be considered as well as a new way to develop software for such multicore systems in an appropriate way. The goal is, to create a tool platform for developing software, which leads towards a collaborative, more efficient process. The goal of evaluating the tool platform is, to show in which ways the development of software for multicore systems can be improved and how this can be done.
Within this consideration, the meaning of the word efficiency has to be seen as relative. Every single company has got different processes, methods and tools, which are used to develop software. By analyzing the actual state it was recognized, that the expectations are also different concerning an efficient working with the tool platform. Moreover the use of the AMALTHEA tool platform means also a paradigm shift form a single core architecture to a multicore architecture.
This paradigm shift has to be taken into account to objectively evaluate the potential of the tool platform. In order to find Key Performance Indicators (KPI), which do not neglect this fact, there cannot be used predefined standard KPIs. Furthermore, a combination of evaluation methods is necessary, to get Indicators, which match with the specific goals.

It was useful for the further examinations to draw on the Balanced-Scorecard-Approach. In combination with the CMMI-Model a good-practice-approach can be reached, that enables the evaluation of the efficiency by using a set of KPIs without forgetting the specific perspectives of every single company. During the project work with the partner companies it was put outside that a classification of the set of KPIs has to be done into quantitative and qualitative measures. At a later time, this separation helps to guess the expenditure for future projects.

The following table shows shortly all the identified KPIs in dependence to the companies and their prevailing conditions.

Quantitative	**Qualitative**
Development time	Faultlessness
→ Function-Point-Method	→ Error rate
→ Transformation time	Defect Removal Effectiveness
→ Duration of iterations	System Spoilage
Expenditure for Changeability and Extensibility	
Expenditure for upkeep and maintenance	

Figure 4: Quantitative and Qualitative KPIs

To summarize the contemplation it can be recorded, that the involved companies expect improvements for all objectives of the magic triangle. Usually, a tool for improving the development process for software engineering has effort in one of the three objectives cost, time and quality. But by using the AMALTHEA tool platform it is possible to improve the three objectives simultaneously. At the present point of time, the tool platform was not in use for daily work, so measures wouldn't have been meaningful. Rather an educated guess of the involved, experienced people offers itself.
In particular, a reduction of the turn-around-time is estimated at about 50% concerning the first iteration. All following iterations could be reduced even more efficient, because the setup time has just to be included at the first iteration.
Concerning the system spoilage, it should possible to detect and remove timing errors for example during ca. 10 minutes, where formerly 3-4 hours were necessary. This results from the possibility to integrate various tools from different suppliers, which automate the formerly manual effort.
To prove the educated guesses it is necessary for the future development to take measurements, when the tool platform is used in a daily modality.

7. Conclusion

This paper has presented the AMALTHEA tool platform with focus on partitioning and mapping as well as its benefits in developing automotive embedded systems. For this purpose, we have discussed EDF and LGP based partitioning techniques for DAGs, which are used for solving the task partitioning problems. With regard to mapping, ILP based methods have been presented, which provide an optimal mapping generations towards a specific goals, e.g. energy efficiency. Moreover, KPIs have been derived, which allow a measurement of the AMALTHEA tool platforms efficiency in comparison to existing development approaches. Furthermore an introduction to three different types of MOAs has been given, followed by the description of the MOA that was implemented in the AMALTHEA project. Afterwards an evaluation of the four MOAs has been presented.
In future work, we expect to extend the partitioning and mapping methods and offer multiple optimization objectives, e.g. memory utilization. Furthermore, measurements based on daily modality will be performed to show the precise gain of the AMALTHEA tool platform and in order to reveal further optimization potential.

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A remote management concept for distributed energy information and facility management systems

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Keywords: Authentication, two-factor authentication, visual identifier, mobile tag, QR Code, app, Android, client-server model

Abstract: This project deals with the development and realisation of a concept to authenticate participants in a distributed communication environment by the use of QR (Quick Response) Codes as visual identifiers. In this context all tools will be provided and a complete infrastructure will be build up. Basically one tool creates the QR Codes, another tool is an Android app for reading and processing them. The infrastructure is based on a client-server model. In fact the verification of the participants is done by two separate identifiers (two-factor authentication) on the server side [1].

1. Introduction

Nowadays the main problem of the initial operation of new hardware in an established environment is the complexity. The user must deal with different and confusing menu structures or has to enter usernames, passwords or hardware identifiers e.g. IP addresses. This procedure wastes time and is very error-prone [2]. It has to be clarified if it is possible to simplify the interactions between user and device and also between the devices directly. The concept introduces a possibility for a faster and easier authentication to allow an efficient bringing into service.

When a new device is added to an infrastructure, it is unknown to the already active devices and has to be authenticated first. This is done by the use of mobile tags, in this case a QR Code and an Android smartphone with an integrated camera. Technically the authentication is initialised on the smartphone, but the logic is implemented on a dedicated server which provides the device-specific information.
The motivation is the development of a complete client-server infrastructure to demonstrate the authentication based on a mobile tag. Other approaches are demonstrated to unify the cooperation of different systems (interoperability).

2. Basics

As mentioned before the authentication is done by the use of mobile tags. Tagging is defined as adding additional information (metadata) to an object. The common term mobile tag is essentially characterised by the business-to-consumer (B2C) market in the commercial environment e.g. in magazines or on billboards. The capturing of mobile tags can be done either by touching – e.g. radio-frequency identification (RFID) or Near Field Communication (NFC) – or by visual detection within a distance up to several meters (e.g. barcodes). The inclusion of a smartphone is a machine-to-machine interaction (M2M), therefore several steps in the human-to-machine interaction (H2M) are dropped [2]. This way the complete procedure is reduced to

fewer steps and the user is reaching the goal quickly. Mobile tags are optimised for machine readability and are faster to process in this way. This is one of the many reasons why mobile tags have been established in the society in a short time.

In this concept the mobile tag contains an identification number that is uniquely assigned to a device. One part of it is the Universally Unique Identifier (UUID), which is a common standard in the software development [3]. An UUID does not contain any information about the object. This information has to be requested from a dedicated server. For the immediate and correct order of processing of the captured mobile tag, additional metadata is inserted at the head of the content. Otherwise a permanent connection to the server is necessary

The realisation is exemplarily applied to a predefined distributed infrastructure based on an energy information and facility management system that is basically installed in private homes or small and medium-size businesses. Every building shall be equipped with an inhouse-controller which captures and processes data from connected metering devices. The inhouse-controllers as well as the devices have to be deployed in the roll-out. Depending on the size of the scenario, a large number of devices must be prepared for the initial operation.
Another important instance is the dedicated server which is remotely connected. The server can communicate with any inhouse-controllers. The essential task of the server is to provide and evaluate data within the energy information system.

3. Realisation

The realisation is subdivided into four modules. Their implementation has been done in Java 7 and Android.

Module 1 is the dedicated server that provides the database with the device-specific information for authentication. Therefore the IP address of the server has to be static and known to every device within the communication environment. Module 2 is an application to create QR Codes. The content is saved to the server at creation. An implemented feature is a function to create Design QR Codes that contain a logo in the centre of the QR Code which allows an individual design. The output format of the created QR Codes are images, which can be printed out and placed on the related objects. Module 3 is a smartphone app. The main task of the app is to capture the QR Codes and send the data to the dedicated server for processing. It was developed for Android, but porting to other platforms like Windows Mobile Phone or iOS is possible, because the applied libraries have already been ported [4] [5]. Module 4 is the device with a placed mobile tag to demonstrate the authentication procedure and serves as an example.

In the exemplary realisation the communication with the server takes place by a simple request response sequence protocol based on the Knock Knock example of Oracle [6]. In a productive operation a more reliable protocol like Remote Method Invocation (RMI) or Web services should be applied.
The transmission of sensible data is anonymised by the use of Secure Hash Algorithm (SHA-256). This becomes possible by generating the checksums of the data on the server side and the simple match of the values.

4. Two-factor authentication

The main feature of this concept is the two-factor authentication, which is realised by two separate identifiers called Activation Code and Device ID.
The Activation Code is a component that authenticates the user and can be delivered by a separate transmission path to him, e.g. by mail or over a web-based user interface. On the other hand the Device ID is already placed on the device at arrival. It is assigned to a device by a unique identifier. This can be the MAC address of the network interface. Unfortunately this is not recommended, because the MAC address is easy to manipulate. Because of this reason an additional identifier was directly integrated into the file system of the device (embedded system, e.g. inhouse-controller). For security reasons the whole device has to be secured against any kind of physical manipulation.

The developed authentication procedure of a new device is described as follows (fig. 1):
At the first launch of a new device (inhouse-controller), it is initialising the communication to the dedicated server (Request 1). Although the device is known to the server the communication will be blocked (Response 1), because it can't be assigned to a user. In other words, it is unknown where the device is. Both QR Codes separately do not permit a clear assignment in the infrastructure. When they are captured by the app on the smartphone and processed by the server (Request 2, Response 2) the unique assignment is possible. The next time the device is sending a periodic request to the server, it will be responded (Request 1, Response 1).

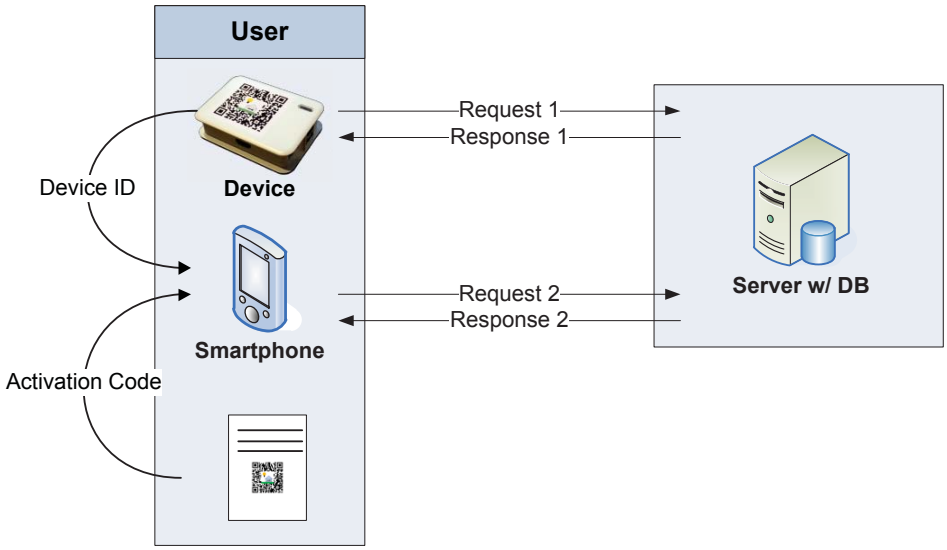

Figure 1: Two-step authentication of a new device

5. Results and Conclusion

The approach introduced for the authentication of a new device by a mobile tag, smartphone and dedicated server can be considered as evaluated successfully. A complete infrastructure was realised for a demonstration consisting of several tools for creating QR Codes, an Android app for capturing and processing the mobile tags, an exemplary device for authentication as well as the dedicated server, which provided the necessary procedures. Moreover all required protocols for communication between the involved actors were implemented.

The main advantage is that the allocation takes finally place at the users' operation site. This results in the possibility of a faster process of multiple users in the transaction chain at the company side at the beginning of the collaboration.

The possible field of application for mobile tags is almost unlimited. Indeed the use of common bar codes would also be sufficient for authentication. Unfortunately they are not up to date, because of less data density and several features like integrated error correction. Moreover the QR Codes can be customised and are easier to recognise by the user because of their distinctive appearance.

Finally the approach has still great potential for extensions. For example the entire system can be further extended to a standardised procedure to connect devices across systems regarding a better interoperability.

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A web-based data analysis system with a flexible data link and dynamic GUI parametrization

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Keywords: Energy data, database management system (DBMS), data analysis system, web analysis application, Vaadin, Hibernate.

Abstract: Due to the development of traditional energy supply to a smart grid, modern energy information systems have gained importance. The number of smart meters for gas, water and electricity is growing rapidly to provide for a reliable control of the system. The next challenge is to structure, analyze and illustrate the large amount of collected data. In this work a concept is presented for filtering and converting the measured data. The other key point is the web-based user interface for setting filter parameters and visualization and processing of data for further analysis.

1 Introduction

The aggregation of producers and consumers in a Smart Grid from single buildings up to a virtual power plant requires a detailed measurement data logging, which can quickly evolve to Big Data and needs to be well organized. To achieve better memory usage and latency in a data management system, the data has to be structured, managed and evaluated. In the next step this data has to be made as comprehensible as possible for the user. It needs to be reduced to the required information and customized according to requirements (e.g. due to conversion or sorting). The visualization of the results via charts provides further insight.

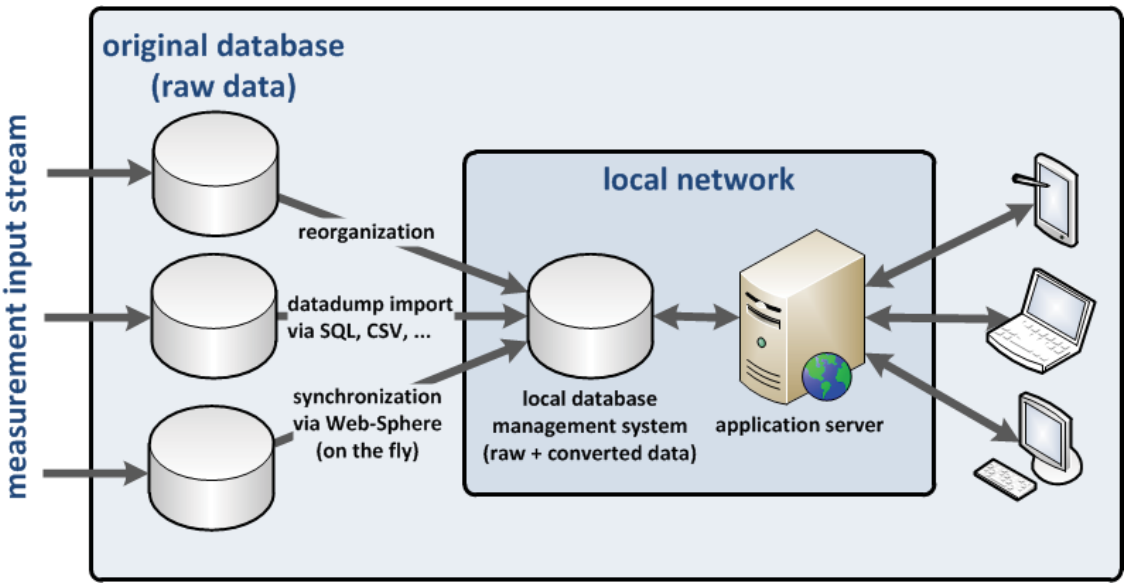
In this work a data analysis concept is presented, based on results of [1]. This concept includes a web application for data-processing and data-visualizing. The proposed system is characterized by its modular and flexible structure. The modules are connected through abstract interfaces. Thus, the possibility is given to connect different data systems to the same visualization module without any or little effort. The logic for the data access and the processing of the output data must be re-implemented in any case. However, a number of provided methods should simplify the implementation process.

2 Requirements

The application has to be available for the analysis of data from different data sources, without implementing the whole project again. The filter functions of the GUI have to be dynamically adapted to the analysis requirements. The filter layout is implemented by the interface. The filter parameters, data access and conversion operations shall be carried out in a separate unit and communicated to the visualizing unit at the runtime. In other words, the application has to be implemented according to the Model-View-Controller (MVC) principle.

3 System architecture

The aim is to develop a system which can be used with a minimum of effort for any data source. To avoid a critical load, it is best practice to manage both the database and the application in a local network (see figure). If the original layout is used, the data can be created in two ways: The dumps of the original database system are imported locally (e.g. using SQL commands). This can be done automatically or manually. The other possibility is to perform the data synchronization "on the fly", using synchronization tools, such as IBM Web Sphere [2]. If the data layout needs to be remodeled, an additional instance is established to convert the data into the desired layout.



system architecture

4 Management and delivery of the output data

The functionality for data management and providing the output data is described here.

User administration: The application is multitenant. That means that several users can use the application at the same time with a customized data access for each user. During the registration process, the user and password input is compared to internal entries (such as a database table). After a successful log-in, the functionality and filter functions are available depending on the active user.

Definition of the filter parameters: First, the filter parameters must be defined in order to give the user the ability to restrict the data according to his needs and convert data using defined conversion rules. The filter criteria such as time period, time resolution, device profile (which includes the parameters calculation method, medium, unit and group assignment) can be specified. The definitions of the filter parameters and the associated selection elements are provided in form of Java objects in the GUI and can be extended or adapted dynamically.

Determination and format of the output time stamps: Before accessing and calculating data a time stamp list in UNIX format has to be created. Afterwards, an output value is assigned for each time stamp. The first time stamp is equal to the set start time and the last time stamp is equal to the set end time. All other time stamps are between these two. Each of them is according to the first millisecond within the set time resolution section. Example:

Set start time: 1359862608 (3-Jan-2013 04:36:48), set end time: 1362408452 (4-Mar-2013 15:47:32), set resolution: month, returned output times:

Timestamp: 1359862608 (3-Jan-2013 04:36:48)

Timestamp: 1359673200 (1-Feb-2013 00:00:00)

Timestamp: 1362092400 (1-Mar-2013 00:00:00)

Timestamp: 1362408452 (4-Mar-2013 15:47:32)

The obtained time stamps have to be formatted for output (x-axis labeling). The aim here is to get as short a string as possible in order to avoid the overlapping of two adjacent labels. For this purpose, all constant time units in the considered time period must be omitted. Examples:

A: resolution: month, period: 3-Feb-2013 04:36:48 – 4-Mar-2013 15:47:32

→ Format: dd.MM. hh:mm:ss

B: resolution: month, period: 1-Jan-2013 00:00:00 – 1-Feb-2014 00:00:00

→ Format: MM.YYYY

C: If there is only one time stamp, the complete date format is to use:

→ Format: dd.MM.YYYY hh:mm:ss

D: If no resolution is given, the average time interval between two time stamps is determined as follows:

$$\Delta t = \frac{(t_{last} - t_{first})}{N_t}$$

where t_{first} is the first and t_{last} is the last time stamp and N_t is the number of time stamps. In the next step a resolution is sought, the duration of which is closest to the value Δt.

Database access: the data can be managed by any DBMS. The data access must be implemented depending on the DBMS and the database layout. The database connection is established via Hibernate [3], an object-related mapping framework for Java. One of the tasks of Hibernate is to manage the session for the transaction and the mapping of the database sets into Java objects (POJO). The query string for the database access is assembled dynamically, depending on the set parameters such as time, location ID and database table. Incoming data is mapped into a Java object list.

Error detection and correction: Errors in the database data can have different causes that can lead to different effects. By consistency and plausibility check the missing or failure values can be detected and corrected by substitute values.

Calculation of the output data: In some cases, the raw data can be taken for output. However, often a conversion is required. In this case, the Java library provides an extensive base of computational functions. Other methods have been implemented for the analysis system, which include the calculation and conversion of measurement series. In addition to the general calculation methods (e.g. sum, average value, variance, co-variance, standard deviation) energy-specific methods are provided, such as:

- physical quantity calculation (e.g. watt – watt-hour)
- ratio calculation (e.g. degree of efficiency)
- Unit (e.g. joule – watt-hour) and unit prefix conversion (e.g. kilowatt – watt)
- Determining the annual and daily energy demand (heating, electricity, hot water), and scaling of the signal on the daily total in percentage according to VDI4655
- Calculating the fuel amount of energy according VDI4655.

5 Graphical user interface

The GUI is based on the web application framework Vaadin [4]. This allows a design of a visually appealing, event-based user interface. The organization of the user interface occurs dynamically depending on the defined filter criteria and the filter criteria options. The obtained output data is visualized in the form of charts or tables (e.g. CSV file).

Worth mentioning is the dependency between the selected time period and the suitable resolution time units. Resolution options with greater time range than the selected time period are not suitable. These options are hidden dynamically in the selection. The resolution must be chosen appropriately so that the maximum number of displayable data points is not exceeded. The following inequality must be performed:

$$n * \Delta t_R \geq \Delta t_T \,, \qquad and\ \Delta t_R \leq \Delta t_T$$

n:	Maximum number of displayed data points
Δt_R:	Time resolution
Δt_T:	Total time period to be analyzed

6 Results and Conclusion

With the implementation of the Model-View-Controller concept, the graphical filter setting and the data output can be dynamically adapted to the requirements of data analysis. Due to encapsulation of individual functions, the system can be easily extended with new filter criteria. For the determination of the output data numerous function blocks are available, so that the implementation of project-specific data processing requires as minimal effort as possible.

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Predictive Analytics on SAP HANA

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Keywords: Columnar Data Storage, Data Mining, Decision Tree, Ensemble Method, In-Memory Computing, Massive Parallel Processing, Predictive Analysis Library, Random Forest, SAP HANA.

Abstract: This paper deals with predictive analytics on SAP HANA and the implementation outcome of the project *Raising the power of Ensemble Techniques*. A comparison of approaches for predictive analytics on SAP HANA is carried out as well as the implementation of a decision tree and a random forest algorithm on SAP HANA. All approaches and implementations are tested in terms of speed and prediction accuracy.

1. Introduction

We are living in the information age in which data, information and knowledge is rapidly growing. Companies are standing before the big challenge to handle this massive volume of data [14]. On the one hand, companies have to ask themselves which techniques they should use to extract and obtain useful information out of this data flood. They will have to think about things like data warehousing, reporting, text mining, OLAP systems and of course data mining [6, 17]. On the other hand, they have to decide which IT infrastructure shall be used to process such techniques with heavy workload in an economical and powerful way. Future trends are to spread the workload out on multi clusters or to process heavy tasks on big single computers with advanced technologies. One product of the last mentioned trend is the in-memory platform SAP HANA, which combines new technologies like in-memory computing, parallelization and columnar data storage [13].

This paper focuses on data mining techniques performed on SAP HANA. As SAP's database has already big influence on the IT market and at the same time data mining on HANA is still more or less unexplored, this area is highly relevant for the current economy and offers a wide range on scientific research.

2. Project Idea

The overall project idea is to run further developed prediction algorithms in a powerful IT environment to gain both, high prediction accuracies and very fast algorithm processing.

Why Ensemble Methods?
Predictive statistical data mining has evolved further over the recent years and remains a steady field of active research. The latest research results provide new data mining methods which lead to better results in model identification and behave more robustly especially in the domain of predictive analytics. The application of new sophisticated predictive data mining techniques enable business processes to leverage hidden potentials [1,2,6,9,10,25]. One of those further developed techniques are ensemble methods. This project is based on those ensemble methods as they have already demonstrated their outstanding behavior in the domain of data mining [4,10].

Why SAP HANA?
SAP HANA is chosen as the project environment because it is a "flexible, data-source-agnostic toolset […] that allows you to hold and analyze massive volumes of data in real time" [3]. It enhances data processing by sophisticated technologies like Massive Parallel Processing (MPP), in-memory computing, columnar data storage and others [3,11,15,20]. Through this project the powerful capabilities of SAP HANA shall be exploited to gain fast processing of CPU-intensive predictive calculations.

3. Theoretical Background

3.1 Data Mining, Decision Trees and Ensemble Methods

Berry and Linoff define data mining as "the process of exploration and analysis, by automatic or semi-automatic means, of large quantities of data in order to discover meaningful patterns and rules" [16]. In short, data mining involves the process of extracting specific information out of vast chunks of data, exploring the patterns in data and overall knowledge discovery in databases. Data mining tools and techniques are used to recognize unknown or hidden information in large amounts of collected data. It provides essential tools with which large volume of data and information can be analyzed and thus it can be considered as a central step in the knowledge discovery in databases (KDD) [18].

The decision tree model is considered to be one of the most famous data mining methods for classification. It is a prediction model which classifies an object or instance. A decision tree helps to identify the factors to consider and how each factor has historically been associated with different outcomes of the decisions. It uses a tree-like structure with many conditions and their possible consequences. Every decision tree begins with a root node, followed by other nodes and leafs. Each node in the tree evaluates an attribute in the data and determines which path it should follow [18].

For ensemble models a variety of models are constructed and combined at the end. Those single models are called *weak learners*, as they only get a subset of data by selecting only from a sample of training rows (*bagging*) and by choosing only from a sample of attributes (*randomization*). Anyway, their prediction accuracy is very accurate as all predictions are considered for the final result. A random forest model, for example, exist of several decision trees, every single tree different from each other. Every Tree is doing its own prediction and at the end, a voting will determine the overall prediction of the random forest. Especially for classification tasks, ensemble methods show powerful behavior which includes that [4,5,24]:

- they exhibit an excellent accuracy,
- they scale up and are parallel by design,
- they are able to handle thousands of variables, many valued categories, extensive missing values and badly unbalanced data sets,
- they give an internal unbiased estimate of test error as primitives are added to ensemble,
- they can hardly overfit,
- they provide a variable importance and
- they enable an easy approach for outlier detection.

3.2 SAP HANA

SAP HANA is the next generation of in-memory computing technology. HANA stands for High Performance Analytical Appliance. The SAP HANA in-memory database solution is also a "combination of hardware and software that optimizes database technologies to exploit parallel capabilities" [3]. Main features of SAP HANA are:

In-Memory Computing
In-memory computing means that data is stored completely in RAM instead of main disk. Being in-memory is the main feature of SAP HANA database as it enables high speed access to data. Furthermore, the database contains many query processing engines such as OLAP engine, row engine or join engine. These engines increase the query performance as well [11].

Columnar Data Storage
Core of SAP HANA database is the column-based storage. Main idea is that the data of each column is stored consecutively on disc or RAM and therefore can be retrieved very fast. Column-based tables are read optimized and have better compression than row-based tables. They are typically suitable for big tables with bulk updates. However, update and insert performance is better on row tables. Row-based storage is typically suitable for small tables with frequent single updates. SAP HANA database supports both, row-based and column-based storage [3,19,23].

Massive Parallel Processing
Due to SAP HANA column based storage, parallel processing on multi-cores is possible. SAP HANA is designed to do basic operation in parallel such as calculations, analytics and aggregations. If multiple columns need to be searched or aggregated at the same time, each column can be assigned to a separate core. It is even possible to divide a column in sections and to assign each section to a separate core [20]. In short words, parallel processing is like "divide and conquer" [15].

4. Work Packages

4.1 Work Package 1: Comparison of approaches for predictive analytics on SAP HANA

There are two ways to use HANA for data analysis. Firstly, SAP is offering data mining techniques which are a part of the SAP HANA environment. SAP developed the Predictive Analytics Library (PAL) in 2013, which contains more than 40 well known algorithms in the fields of classification analysis, data preparation, outlier detection, cluster analysis, time series analysis and others [21, 22]. Secondly, it's possible to extend HANA by runtime environments, which makes the usage of other analytical languages feasible. In this paper R is chosen as a representative of all languages, which can run in an extended environment (see Figure 1).

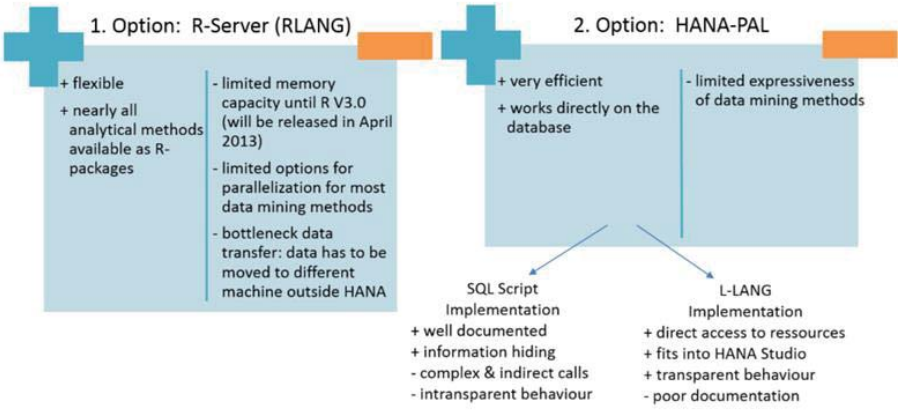

Figure 1: Comparison of Analytic Options [8]

To compare both approaches, two algorithms are chosen, the decision tree and the random forest algorithm. The C4.5 decision tree algorithm with variations of learning parameters is used on the PAL side, while the C5.0 implementation with default settings is applied on the R side. It turns out that the PAL C4.5 implementation shows significant longer training times compared to a

similar R approach (see Appendix 1). The reason is given by the fact that this implementation is relatively new and programmers have not taken the full potential of the HANA architecture [4]. The accuracies of both approaches on different datasets are similar with some variations of the results due to training parameter variations [8].

Ensembles are created by using weak learners and the principles of bagging and randomization. Some simplifications have to be applied due to the limited flexibility of the PAL C4.5 decision tree implementation. Randomization can only be done on a tree level instead of a node level and the pruning of trees has to be accepted which is omitted in standard ensemble methods. Large deviations in accuracy can be identified for most of the data. Only for some datasets the accuracy is comparable between both approaches. It seems that the default settings of randomization (#attributes per split = sqrt(#attributes)) on the node level cannot be transferred on tree level for datasets in general. The results are improving for more attributes per tree. It is remarkable that the PAL ensemble method (RF) in the OPTICAL_REC dataset shows significantly superior accuracy than the PAL decision tree (DT). In general there are big differences in terms of performance as, in the case of PAL, several procedures have to be created and called for each tree of the random forest [8].

4.2 Work Package 2: Implementation of Predictive Algorithms on SAP HANA from scratch

So far is the main statement that the R approach is faster than the usage of PAL, even if it runs on an extended server and therefore data has to be transferred between the HANA and R environment, in addition to the main calculation time inside the R server. Resulting from this, the overall idea of work package 2 is to implement a prediction algorithm inside SAP HANA from scratch. Furthermore, the result shall be integrated into the Data Scientist Prototype, a workflow tool in SAP HANA Studio, due to the inconvenient usage of PAL and self-written analytical procedures. In the Data Scientist Prototype function nodes can be dragged and dropped, and sequences of comprehensive analytical functions can be created to simplify the usage of PAL and R algorithms (see appendix 2)[7]. The goal is to deliver five nodes for the Data Scientist Prototype, a training and prediction node for both, a decision tree and a random forest, and a confusion matrix to evaluate the quality of those models.

Two languages can be used to build analytical nodes in the Data Scientist Prototype, the R and L language. R must be executed on a dedicated R server and therefore, data must be transferred between those servers. L on the other hand is processed directly in the core of SAP HANA and takes advantage of the HANA capabilities. Hence, L is chosen as the programming language for the implementation. As L is a restricted, SAP internal language, this paper does not go any deeper into the implementation. Instead results are summarized at this point.

Performance Results (tested with the decision tree algorithm)
For small data sets the performance times of the L implementation are similar to the PAL implementation. For larger data sets the PAL implementation delivers better performance results (see appendix 3).
There are three reasons for this performance issue [7]:

- The random forest method is implemented from scratch in a new language. There are some opportunities to improve the performance of this algorithm. An option is to use pointer methods pointing on selected rows instead of building new tables, in which selected rows are inserted.
- Time intensive iterative L commands are used instead of fast SQL commands for selecting data and doing projections on tables. The usage of SQLScript would deliver better performance results.
- Parallelization can't be used, as access to the newest version of the Data Scientist Prototype in not possible in this project period.

Accuracy Results (tested with the decision tree algorithm)
The prediction results are satisfying and the implemented algorithm runs reliably. Depending on the data set, parameters and the selection of test and training data, the prediction accuracy can either be better or worse compared to the PAL C4.5 decision tree (see appendix 3)[7].

5. Results and Conclusion

In the first step of this project, possible approaches for predictive analytics on SAP HANA were evaluated and tested. Contrary to our assumption, the R implementation delivers better performance results than the PAL implementation even if data has to be transferred between two servers. Therefore a random forest was implemented directly in SAP HANA by using L. This implementation delivers accuracy results comparable to the R implementation. Unfortunately, the speed of PAL cannot be achieved with the current implementation by now.

There are a lot of opportunities to use this project results for further improvements. Different parts of the L implementation can be optimized. Furthermore, more options and approaches to work on SAP HANA should be considered, as for example the application of C++ and the usage of parallelism. Beside the performance improvement, there are some options to optimize the algorithm and its prediction quality, for example different approaches for identifying the best split for numeric attributes or implementing a post pruning by regarding a validation data set.

There is no doubt about the big influence of SAP HANA on today's and future's economy. Not least because hardware gets cheaper year by year and thus in-memory-systems get affordable for more and more companies, this technology highly influences the IT market. Likewise the importance of data mining, which for companies means the ability to gather information out of data, can't be called into question. To make data mining on SAP HANA more interesting for companies, SAP has to enhance usability and functionality of PAL. With revision SPS07, HANA contains further PAL functions and also simplifies the usage by providing a graphical editor [22]. Those are necessary steps towards a higher customer's recognition. A combination of an improved data mining portfolio and the high performance of the SAP HANA technology can lead SAP to achieve growing market shares in this area.

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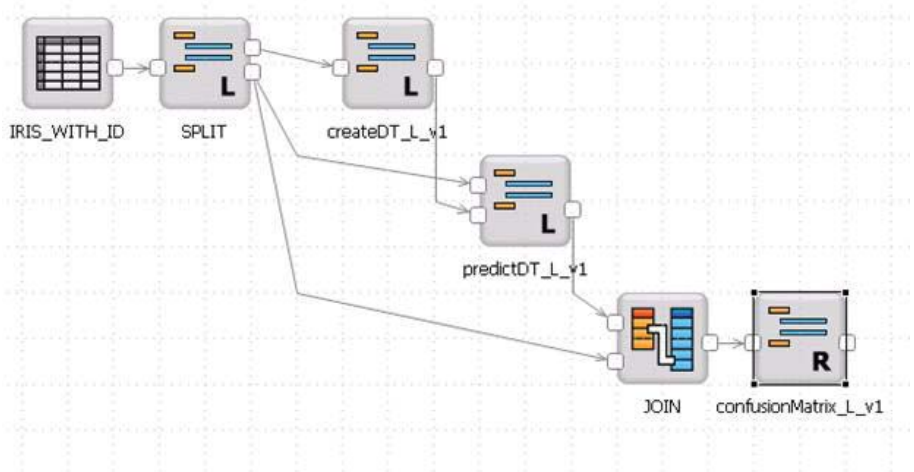
Appendix

Appendix 1: Test Results - Decision Tree and Random Forest with PAL and R (tested in August 2013)

Data	RF / DT	Time RF PAL (overall)	PAL Time Training	Time Testing	Accuracy	R Time Training	Time Testing	Accuracy
Dataset IRIS (150rows)	DT	--	95 ms	34 ms	94%	13 ms	6 ms	92%
	RF	15 min	--	--	95%	23 ms	4 ms	97%
Dataset KRKOPT (28056rows)	DT	--	7 sec	2 sec	59%	1 sec	332 ms	63%
	RF	18 min	--	--	27%	14 sec	231 ms	68%
Dataset Covertype (581.012rows)	DT	--	3:54 min	10 sec	69%	2:18 min	28 sec	94%
	RF	10 h 50 min	--	--	53%	26 min	10 sec	84%
Dataset Pokerhand (1.025.010rows)	DT	--	1:18 min	22 sec	93%	1:21 min	30 sec	84%
	RF	30 min	--	--	50%	158 min	35 sec	85%
Dataset CONNECT4 (67.557rows)	DT	--	19 sec	896 ms	77%	12 sec	5 sec	79%
	RF	13 min	--	--	65%	1:08 min	1,6 sec	81%
Dataset OPTICAL_REC (5.620rows)	DT	--	3 sec	562 ms	61%	898 ms	327 ms	89%
	RF	29 min	--	--	91%	6 sec	74 ms	98%
Dataset GLASS (214rows)	DT	--	160 ms	99 ms	64%	21 ms	11 ms	70%
	RF	15 min	--	--	63%	41 ms	5 ms	80%

Appendix 2: Decision Tree Workflow in Data Scientist Prototype



Appendix 3: Test Results - Decision Tree with PAL and L
(tested in March 2014)

Dataset	Llang / PAL	Create Decision Tree			Predict Decision Tree			
		Data Quantity	Parameter	Performance	Data Quantity	Parameter	Performance	Accuracy
Iris (150)	PAL	95	THREAD = 16 SPLIT MODEL = 1 PMML EXPORT = 2 MIN_REC = 2	95 ms	55	THREAD = 16	34 ms	0.94
	Llang	95	Max_Tree_Size = 100 MIN_REC = 2	62 ms	55	-	23 ms	1
KRKOPT – chess data (28.056)	PAL	17.675	THREAD = 16 SPLIT MODEL = 1 PMML EXPORT = 2 MIN_REC = 2	7.08 sec	10.381	THREAD = 16	2.23 sec	0.58
	Llang	17.675	Max_Tree_Size = 30 MIN_REC = 2	18.18 sec	10.381	-	14.79 sec	0.55
	Llang	17.675	Max_Tree_Size = 30 MIN_REC = 10	10.17 sec	10.381	-	3.06 sec	0.52
Pokerhand (1.025.010)	PAL	645.756	THREAD = 16 SPLIT MODEL = 1 PMML EXPORT = 2 MIN_REC = 2	1:18 min	379.254	THREAD = 16	22 sec	0.92
	Llang	20.000 (subset)	Max_Tree_Size = 30 MIN_REC = 2	41 sec	379.254	-	5:27 min	0.61
	Llang	50.000 (subset)	Max_Tree_Size = 15 MIN_REC = 10	3:44 min	379.254	-	6:51 min	0.64
	Llang	100.000 (subset)	Max_Tree_Size = 15 MIN_REC = 4	11:01 min	379.254	-	14:44 min	0.71
Connect4 (67.557)	PAL	42.560	THREAD = 16 SPLIT MODEL = 1 PMML EXPORT = 2 MIN_REC = 2	18.41 sec	24.997	THREAD = 16	986 ms	0.77
	Llang	20.000 (subset)	Max_Tree_Size = 30 MIN_REC = 2	1.55 min	24.997	-	8.6 sec	0.73
	Llang	20.000 (subset)	Max_Tree_Size = 10 MIN_REC = 20	0.45 min	24.997	-	1.9 sec	0.74
Optical_Rec (5620)	PAL	3.540	THREAD = 16 SPLIT MODEL = 1 PMML EXPORT = 2 MIN_REC = 2	3.7 sec	2080	THREAD = 16	562 ms	0.61
	Llang	1.000 (subset)	Max_Tree_Size = 64 MIN_REC = 2	11 sec	2080	-	215 ms	0.82

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